

A

0
0
0
3
9
1
9
6
4
4

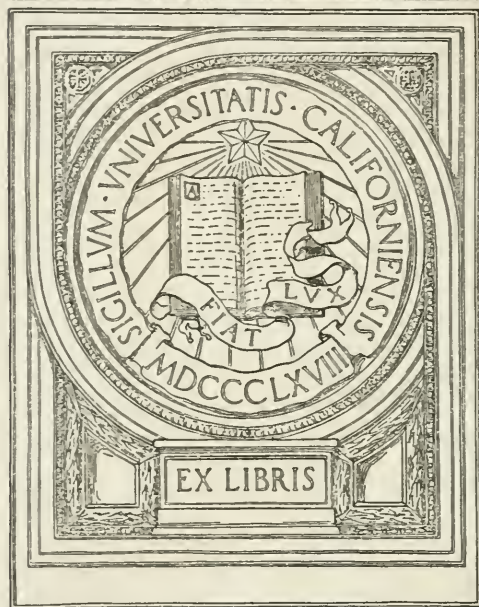


METROPOLITAN WATER AND SEWERAGE BOARD

SIXTEENTH ANNUAL REPORT

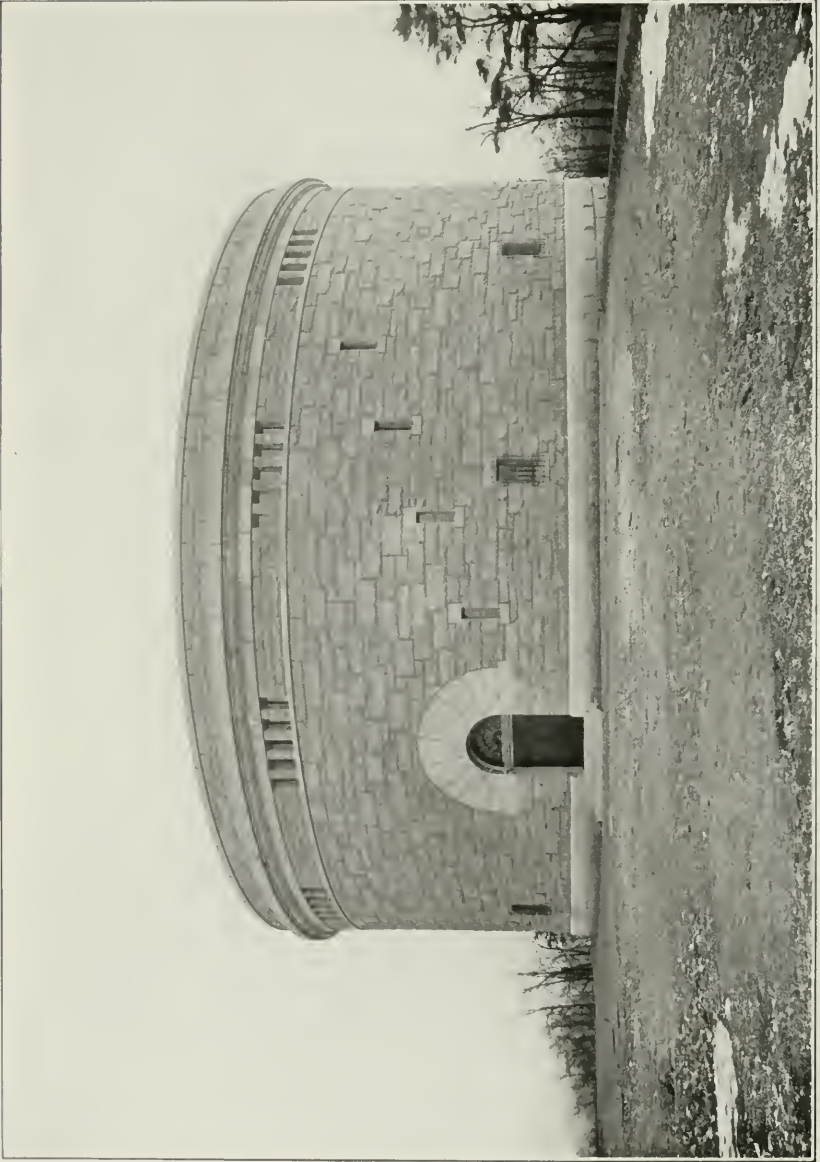
DECEMBER 31, 1915

UNIVERSITY OF CALIFORNIA
AT LOS ANGELES



EX LIBRIS

GIFT OF
MR. C. W. COOK



BELLEVUE RESERVOIR.

SIXTEENTH ANNUAL REPORT

OF THE

METROPOLITAN WATER AND
SEWERAGE BOARD.

FOR THE YEAR 1916.



BOSTON:

WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
32 DERNE STREET.

1917.

PUBLICATION OF THIS DOCUMENT
APPROVED BY THE
SUPERVISOR OF ADMINISTRATION.

CONTENTS.

	PAGE
I. Organization and Administration,	1
Board, Officers and Employees,	1
II. Metropolitan Water District,	3
III. Metropolitan Water Works — Construction,	3
IV. Water Works — Maintenance,	5
(1) Storage Reservoirs,	5
(2) Aqueducts,	6
(3) Pumping Stations,	6
(3) Protection of Water Supply,	7
(5) Clinton Sewerage Works,	8
(6) Forestry,	9
(7) Wachusett Power Plant,	10
(8) Sudbury Power Plant,	10
(9) Rainfall and Water Supply,	10
(10) Water Consumption,	11
V. Water Works — Financial Statement,	11
(1) Water Loans — Receipts and Payments,	12
(2) Total Water Debt, December 31, 1916,	12
(3) Metropolitan Water Loan and Sinking Fund,	13
(4) Water Assessment, 1916,	13
(5) Supplying Water to Cities and Towns outside of District and to Water Companies,	14
(6) Expenditures for the Different Works,	15
(7) Detailed Financial Statement under Metropolitan Water Act,	17
(a) Expenditures and Disbursements,	17
(b) Receipts,	22
(c) Assets,	23
(d) Liabilities,	23
VI. Metropolitan Sewerage Works,	24
(1) North Metropolitan Sewerage System — Construction,	25
(2) North Metropolitan Sewerage System — Maintenance,	25
Sewers and Pumping Stations,	25
(3) South Metropolitan Sewerage System — Construction,	26
(4) South Metropolitan Sewerage System — Maintenance,	28
Sewers and Pumping Stations,	28
VII. Sewerage Works — Financial Statement,	29
(1) Metropolitan Sewerage Loans, Receipts and Payments,	29
North Metropolitan System,	30
South Metropolitan System,	30
(2) Total Sewerage Debt, December 31, 1916,	31
North Metropolitan System,	31
South Metropolitan System,	31
(3) North and South Metropolitan Loan and Sinking Funds, December 31, 1916,	32
(4) Annual Appropriations, Receipts and Expenditures,	33
(5) Sewer Assessments, 1916,	33
(6) Expenditures for the Different Works,	35
(7) Detailed Financial Statement,	36
(a) Expenditures and Disbursements,	36
(b) Receipts,	41
(c) Assets,	42
(d) Liabilities,	42
VIII. Recommendations for Legislation,	43

	PAGE
Report of Chief Engineer of Water Works,	47
Organization,	47
Construction,	48
Completion of 60-inch Weston Aqueduct Supply Main,	48
Improvement of Beaver Dam Brook,	48
Additional 24-inch Main from Dorchester Lower Mills to Quincy,	49
Bellevue Reservoir,	49
Sudbury Power Plant,	50
Wachusett-Sudbury Transmission Line,	53
Additional Northern Extra High-service Pipe Line and Pumping Machinery,	53
Southern Extra High-service Pipe Line,	54
Meters and Connections,	55
Engineering,	56
Maintenance,	56
Rainfall and Yield of Watersheds,	56
Storage Reservoirs,	57
Wachusett Reservoir,	57
Sudbury Reservoir,	60
Framingham Reservoir No. 3,	61
Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs,	62
Farm Pond,	63
Lake Cochituate,	63
Dudley Pond,	64
Aqueducts,	64
Wachusett Aqueduct,	64
Sudbury Aqueduct,	65
Weston Aqueduct,	66
Cochituate Aqueduct,	67
Sanitary Inspection of Watersheds,	69
Wachusett Watershed,	69
Sudbury Watershed,	72
Cochituate Watershed,	72
Protection of the Water Supply,	72
Filtration and Chlorination,	72
Improvement of Swamps and Brooks,	73
Acquisition of Land,	74
Clinton Sewage Disposal Works,	74
Forestry,	77
Wachusett Department,	77
Sudbury Department,	79
Distribution Department,	80
Hydro-electric Service,	81
Wachusett Power Station,	81
Sudbury Power Station,	82
Distribution Pumping Service,	84
Chestnut Hill Pumping Stations,	86
Spot Pond Pumping Station,	88
Arlington Pumping Station,	89
Hyde Park Pumping Station,	90
Distribution Reservoirs,	91
Weston Reservoir,	92
Chestnut Hill, Fisher Hill and Waban Hill Reservoirs,	92
Spot Pond, Fells and Bear Hill Reservoirs,	94
Arlington, Bellevue, Forbes Hill and Mystic Reservoirs,	94
Mystic Lake, Conduit and Pumping Station and Grounds at Arlington and Hyde Park Pumping Stations,	95
Distribution Pipe Lines,	96
Pipe Bridges,	97
Pipe Yards,	97
Meters, Regulating Valves and Recording Pressure Gages,	97
Breaks and Leaks,	98
Emergency Pipe Line Service,	98
Consumption of Water,	99
Installation of Meters on Service Pipes,	102

CONTENTS.

v

	PAGE
Report of Chief Engineer of Water Works — <i>Concluded.</i>	
Maintenance — <i>Concluded.</i>	
Water supplied outside of Metropolitan Water District,	102
Quality of the Water,	103
Engineering,	103
Report of Chief Engineer of Sewerage Works,	104
Organization,	104
Metropolitan Sewerage Districts,	105
Areas and Populations,	105
Metropolitan Sewers,	106
Sewers purchased and constructed and their Connections,	106
Construction,	109
North Metropolitan System,	109
Deer Island Outfall Extension,	109
Section 1, Deer Island Outfall Extension,	110
Section 19, Malden River Siphon,	110
Removal of Old Malden River Siphon,	111
Extension to Reading,	111
South Metropolitan System,	112
Wellesley Extension,	112
Section 98, Wellesley Extension,	112
Section 99, Wellesley Extension,	113
Sections 100 and 101, Wellesley Extension,	113
Section 102, Wellesley Extension,	114
Section 103, Wellesley Extension,	114
Section 104, Wellesley Extension,	115
Maintenance,	115
Scope of Work and Force employed,	115
Deer Island Pumping Station,	116
East Boston Pumping Station,	116
Ward Street Pumping Station,	116
Nut Island Screen-house,	117
Gasoline in Public Sewers,	117
Drainage from Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham,	119
Data relating to Areas and Populations contributing Sewage to Metropolitan Sewerage System,	121
North Metropolitan System,	121
South Metropolitan System,	122
Whole Metropolitan System,	123
Pumping Stations,	124
Capacity and Results,	124
North Metropolitan System,	124
Deer Island Pumping Station,	124
East Boston Pumping Station,	126
Charlestown Pumping Station,	127
Alewife Brook Pumping Station,	129
South Metropolitan System,	130
Ward Street Pumping Station,	130
Quincy Pumping Station,	132
Nut Island Screen-house,	133
Quincy Sewage Lifting Station,	133
Metropolitan Sewerage Outfalls,	133
Material intercepted at the Screens,	136

Appendix No. 1. — Contracts relating to the Metropolitan Water Works made and pending during the Year 1916,	138
Appendix No. 2. — Tables relating to the Maintenance of the Metropolitan Water Works,	145
Table No. 1. — Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works in 1916,	145
Table No. 2. — Rainfall in Inches at Jefferson, Mass., in 1916,	146

Appendix No. 2 — *Continued.*

	PAGE
Table No. 3. — Rainfall in Inches at Framingham, Mass., in 1916,	147
Table No. 4. — Rainfall in Inches at Chestnut Hill Reservoir in 1916,	148
Table No. 5. — Rainfall in Inches on the Wachusett Watershed, 1897 to 1916,	150
Table No. 6. — Rainfall in Inches on the Sudbury Watershed, 1875 to 1916,	151
Table No. 7. — Yield of the Wachusett Watershed in Gallons per Day per Square Mile from 1897 to 1916,	153
Table No. 8. — Yield of the Sudbury Watershed in Gallons per Day per Square Mile from 1875 to 1916,	155
Table No. 9. — Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1916,	159
Table No. 10. — Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1916,	160
Table No. 11. — Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1916,	161
Table No. 12. — Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month,	162
Table No. 13. — Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District,	163
Table No. 14. — Average Daily Quantity of Water flowing through Aqueducts in 1916 by Months,	164
Table No. 15. — Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pump- ing Station No. 1 for the Year 1916,	165
Table No. 16. — Statement of Operation of Engine No. 3 at Chestnut Hill Pumping Station No. 1 for the Year 1916,	166
Table No. 17. — Statement of Operation of Engine No. 4 at Chestnut Hill Pumping Station No. 1 and Summary for the Station for the Year 1916,	167
Table No. 18. — Statement of Operation of Engines Nos. 5, 6 and 7 at Chestnut Hill Pumping Station No. 2 for the Year 1916,	168
Table No. 19. — Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1916,	169
Table No. 20. — Statement of Operation of Engine No. 8 at Spot Pond Pumping Station for the Year 1916,	170
Table No. 21. — Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1916,	171
Table No. 22. — Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1916,	172
Table No. 23. — Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1916,	173
Table No. 24. — Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1916,	174
Table No. 25. — (Meter Basis) Average Daily Consumption of Water by Districts in Cities and Towns supplied by the Metropolitan Water Works in 1916,	175
Table No. 26. — (Meter Basis) Average Daily Consumption of Water in Cities and Towns supplied from Metropolitan Works in 1916,	176
Table No. 27. — (Pump Basis) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1916, and a Small Section of the Town of Saugus, from 1893 to 1916,	179
Table No. 28. — Chemical Examinations of Water from the Wachusett Reservoir, Clinton,	181
Table No. 29. — Chemical Examinations of Water from the Sudbury Reservoir,	182
Table No. 30. — Chemical Examinations of Water from Spot Pond, Stoneham,	183
Table No. 31. — Chemical Examinations of Water from Lake Cochituate,	184
Table No. 32. — Chemical Examinations of Water from a Tap at the State House, Boston,	185
Table No. 33. — Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1916,	186
Table No. 34. — Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1916,	187
Table No. 35. — Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1916, inclusive,	188
Table No. 36. — Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1916, inclusive,	190
Table No. 37. — Colors of Water from various Parts of the Metropolitan Water Works in 1916,	191

CONTENTS.

vii

Appendix No. 2 — <i>Concluded.</i>	PAGE
Table No. 38. — Temperatures of Water from Various Parts of the Metropolitan Water Works in 1916,	192
Table No. 39. — Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1916,	193
Table No. 40. — Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1916,	194
Table No. 41. — Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1916,	195
Table No. 42. — Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1916,	196
Table No. 43. — Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works,	197
Table No. 44. — Average Elevations of the Hydraulic Grade Line in Feet above Boston City Base for each Month at Stations on the Metropolitan Water Works during 1916,	198
Appendix No. 3. — Water Works Statistics for the Year 1916,	200
Appendix No. 4. — Contracts relating to the Metropolitan Sewerage Works, made and pending during the Year 1916,	202
Appendix No. 5. — Financial Statement presented to the General Court on Jan. 16, 1917,	207
Appendix No. 6. — Legislation of the Year 1916 affecting the Metropolitan Water and Sewerage Board,	212

LIST OF ILLUSTRATIONS.

Bellevue Reservoir,	Frontispiece
Interior of Sudbury Power Plant,	50

METROPOLITAN WATER AND SEWERAGE BOARD.

To the Honorable the Senate and House of Representatives of the Commonwealth of Massachusetts in General Court assembled.

The Metropolitan Water and Sewerage Board, established under the provisions of chapter 168 of the Acts of the year 1901, has already presented to your Honorable Body an abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the fiscal year ending on November 30, 1916, and now, in accordance with the provisions of chapter 235 of the Acts of the year 1906, presents a detailed statement of its doings for the calendar year ending on December 31, 1916, being its

SIXTEENTH ANNUAL REPORT.

I. ORGANIZATION AND ADMINISTRATION.

BOARD, OFFICERS AND EMPLOYEES.

The term of office of Edward A. McLaughlin expired on March 20, and he was reappointed for the term of three years next succeeding. At the end of the year the Board consisted of Henry P. Walcott, chairman, Edward A. McLaughlin and Thomas E. Dwyer. William N. Davenport has continued as secretary. Alfred F. Bridgman has been the purchasing agent and Miss Alice G. Mason the bookkeeper.

There are also employed in the administrative office a paymaster, an assistant in auditing, two general clerks, three stenographers and clerks, a telephone operator, and a janitor with two assistants, both of whom act as watchmen.

Such general conveyancing work and investigation of real estate titles in the different counties as have been called for during the year have been performed by George D. Bigelow.

The consulting engineers of the Board are Hiram F. Mills and Frederic P. Stearns, who are called upon for services when matters arise which require their consideration.

William E. Foss, who had been Acting Chief Engineer of Water Works since the death of Mr. Brackett, was appointed Chief Engineer of Water Works in May, and John L. Howard was appointed Assistant to the Chief Engineer in November. The following have continued as superintendents of departments under the direction of the Chief Engineer: Elliot R. B. Allardice, Superintendent of the Wachusett Department; Charles E. Haberstroh, Superintendent of the Sudbury and Cochituate Works and of the portion of the Weston Aqueduct above the Weston Reservoir; Samuel E. Killam, Superintendent in charge of the Weston Reservoir and the remaining portion of the Weston Aqueduct, and of all distributing reservoirs and pipe lines within the Metropolitan Water District; and Arthur E. O'Neil, Superintendent of the several Water Works pumping stations.

The average engineering force employed on construction and maintenance during the year has included, in addition to the Chief Engineer, 4 department superintendents, 1 division engineer, 10 assistant engineers and 29 others in various engineering capacities, and as sanitary inspectors, clerks, stenographers and messengers, the total force numbering 45.

A maintenance force in addition to those engaged in engineering capacities, as above mentioned, numbering upon the average during the year 258, has been required at the pumping stations, upon reservoirs, aqueducts, pipe lines and upon minor construction work. At the end of the year this force numbered 233.

Frederick D. Smith, Chief Engineer of Sewerage Works, has had charge of both construction and maintenance of the works. He has been assisted by Henry T. Stiff, Division Engineer in charge of the office and drafting, by 4 assistant engineers and by 21 others employed in different engineering capacities, and by 2 stenographers and clerks.

The maximum engineering force employed at any one time during the year on the construction and maintenance of the Sewerage Works was 31.

The regular maintenance force required in addition for the operation of the pumping stations, the care and inspection of the sewers, and for other parts of the Sewerage Works, exclusive of the engineers and day-labor forces, on the average has been 163.

The whole regular force of the Sewerage Department at the end of the year numbered 191, of whom the Chief Engineer and 28 assistants and draftsmen were engaged in general upon the works, and of the remainder, 100 were employed upon the North System and 63 upon the South System.

The maximum number of men employed upon contracts and upon day-labor construction on the Sewerage Works during the year was for the week ending June 25, when the number amounted to 195.

II. METROPOLITAN WATER DISTRICT.

The Metropolitan Water District now comprises the cities of Boston, Chelsea, Everett, Malden, Medford, Melrose, Newton, Quincy, Revere and Somerville, and the towns of Arlington, Belmont, Lexington, Milton, Nahant, Stoneham, Swampscott, Watertown and Winthrop, — in all 10 cities and 9 towns. The District has an area of 174.8 square miles, no additional municipalities having been admitted into the District during the year. Its population, according to the State Census taken for April 1, 1915, was 1,201,300. The population of the District on July 1, 1916, the date upon which calculations for the Water Works are based, was estimated as 1,234,180.

III. METROPOLITAN WATER WORKS — CONSTRUCTION.

The total amount expended for the construction and acquisition of the Metropolitan Water Works since the passage of the Metropolitan Water Act in the year 1895 has been \$42,923,591.63.

The total amount expended during the calendar year on account of the construction and acquisition of works has been \$105,420.99. The details of this expenditure are as follows: on account of the construction of a steel tank or reservoir on Bellevue Hill with connecting pipe lines and the reinforcement of the southern high-service pipe lines in Milton, the sum of \$17,679.05; for work on account of the power plant at Sudbury Dam and the construction of the Wachusett-Sudbury transmission line, \$47,190.29; for laying 60-inch Weston Aqueduct Supply Mains, Section 5, \$26,354.15; for relocation of meters and connections, \$3,458.18; for stock on hand, \$2,755.65; and for other minor works, engineering and administration expenses, the sum of \$7,983.67.

A steel tank for the southern extra high-service reservoir on Bellevue Hill in West Roxbury, which is 100 feet in diameter and 44 feet 3 inches in height and has a capacity of 2,500,000 gallons, has been completed during the year and is now in successful operation. The entire work was completed on July 11. The masonry tower which encloses the tank has been built under a contract with John Cashman & Sons Co. The tower is 114 feet 2 inches in outside diameter at the base and 108 feet 2 inches in inside diameter. It is 47½ feet in height from the concrete foundation to the top of the cornice. A parapet wall 4 feet in height above the cornice surrounds the roof. The tower is of Bay View gray Rockport granite backed with concrete, with the exception of that portion of the tower which is below the surface of the ground, which is of concrete.

Work upon the 60-inch Weston Aqueduct supply main, connecting with that portion laid in 1909 and 1910, extending through Commonwealth Avenue to the Charles River, a distance of about 14,500 feet, has been completed. By the completion of this pipe line an addition of 19,000,000 gallons daily has been made to the capacity of the Weston Aqueduct. As the water so delivered is at present sufficient to supply Spot Pond without the pumping which has hitherto been necessary at the low-service station at Chestnut Hill, it will be seen that a very substantial saving has been effected by reason of this reduction in pumping and the direct delivery of the water to Spot Pond.

The construction of the hydro-electric plant to use the water power available at the Sudbury Dam in Southborough has been completed and a portion of the electric energy to be produced was delivered to the Edison Electric Manufacturing Co. on September 14. At the end of the year the full capacity of the station was reached.

It is the intention of the Board to construct an electric transmission line from the station at the Sudbury Dam to the station at Wachusett Dam in order that the full production of these two stations may be used in a manner most advantageous to this project. The transmission line has not yet been built but a part of the material for it has been assembled and it is proposed to proceed with the work during the coming season. Upon its completion of the scheme for the utilization of the power, which would otherwise have been wasted, by the fall of water at these two dams, the Met-

ropolitan District will have secured and will continue to receive for all time a very substantial income, which will not only do something to relieve the burden of debt resting upon the District but will also more than restore to the district in which a serious destruction of existing water powers was made an amount of power far in excess of anything which that district had ever enjoyed.

By chapter 814 of the Acts of 1913 authority was given the Board to improve Beaver Dam Brook in the towns of Ashland, Framingham, Sherborn and Natick. The improvement was offered for contract on July 24 but the lowest bid was \$20,000 in excess of the amount available for the work and the Board was accordingly unable to carry out the provisions of this legislation.

IV. WATER WORKS — MAINTENANCE.

The maintenance and operation of the Metropolitan Water Works during the past calendar year have required the expenditure of \$445,784.99.

(1) STORAGE RESERVOIRS.

The water in the Wachusett Reservoir reached its highest elevation, 395.75, on June 11.

The Sudbury Reservoir was maintained at a low level until March 15 in order to facilitate the changes which were being made at the Sudbury Dam for the installation of the power plant, after which time the reservoir was allowed to fill. Framingham Reservoir No. 3 and Lake Cochituate have been kept nearly full during the greater part of the year.

It has not been necessary to draw water for the supply of the Metropolitan District from Framingham Reservoir No. 1, Framingham Reservoir No. 2, Farm Pond, Ashland, Hopkinton and Whitehall reservoirs and Lake Cochituate.

In accordance with the recommendation made by the Board in its report to the Legislature of last year, an act, chapter 94 of the Acts of 1916, was passed restoring Dudley Pond, which had been hitherto a portion of the Cochituate Lake supply, to the town of Wayland. The transfer of the pond was accepted by the town on April 18.

(2) AQUEDUCTS.

The Wachusett Aqueduct was in service for the passage of water from the Wachusett Reservoir to the Sudbury Reservoir during the whole or portions of 321 days. The quantity of water flowing through the aqueduct was equal to an average of 102,317,486 gallons per day for the entire year. Of the total quantity of water admitted to the aqueduct 79.1 per cent. was used before its admission for the development of electric energy.

For distribution to the cities and towns of the Metropolitan District water was drawn through the Sudbury Aqueduct to the Chestnut Hill Reservoir every day in the year, the daily average for the whole year being 50,360,000 gallons.

The Weston Aqueduct was in use on 353 days, the quantity of water delivered through the aqueduct being equivalent to a daily average of 52,699,000 gallons.

(3) PUMPING STATIONS.

The total amount of water pumped at all the pumping stations was 22,039,270,000 gallons, which is 5,667,030,000 gallons less than in the previous year.

The following are the several pumping stations:—

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Chestnut Hill high-service station,	4	66,000,000	133
Chestnut Hill low-service station,	3	105,000,000	60
Chestnut Hill low-service station,	1	40,000,000	130
Spot Pond Station,	2	30,000,000	125
Arlington station,	2	3,000,000	290
Hyde Park station,	2	6,000,000	140

The amount expended for the operation of the stations was \$98,273.22, which is slightly more than for the year 1915.

The total amount of coal purchased during the year was 7,675.53 gross tons, of which 5,738.18 tons were bituminous and 1,937.35 tons anthracite. All of the anthracite coal was buckwheat and screenings. The cost of bituminous coal delivered in the bins at the various stations varied from \$4.18 to \$5.55, and the cost of anthracite coal varied from \$2.98 to \$3.37 per ton.

(4) PROTECTION OF THE WATER SUPPLY.

The Marlborough Brook filter-beds, on which is filtered the water received from brooks passing through the thickly settled portions of Marlborough, have been adequate for the filtration of all the water received.

The Pegan Brook pumping station, at which is pumped upon the filter-beds the surface drainage of about one square mile in the thickly settled portion of Natick, was in successful operation 251 days in the year.

The filter-beds which receive for filtration the water flowing through the thickly settled portion of the town of Sterling, as well as the smaller filter-beds which receive the drainage from a few houses near Sterling Junction, the Worcester County Training School at West Boylston and from the swimming pool at Southborough, have been in successful operation and required only the usual attention during the year.

Studies for the disposal of manufacturing wastes, as well as for the disposal of house drainage from the various towns within the drainage area of the Metropolitan Water System, have been in progress during the year.

Some of the territory lying about the origin of Gates Brook near the boundary line between the town of West Boylston and the City of Worcester has been for some years a menace to the purity of the waters of the Wachusett Reservoir. Quite recently a number of small houses with insufficient provision for the disposal of their waste matter have been erected in this district. It has seemed to the Board that the most effective remedy for the conditions thus existing would be obtained by the purchase of the margins of the brook and such regulation of its course as would make the direct introduction of sewage into it impossible. The necessary land has been secured and a considerable portion of the work for the regulation of the brook has been effected. This work will be completed during the coming season.

Constant inspection of the watersheds has been maintained by the Sanitary Inspector and his assistants and members of the maintenance force.

Chemical examinations of the waters used were made by the State Department of Health, and in addition, microscopical and

bacterial examinations were made by the Board. These examinations enable the Board to take measures to remedy any difficulties which are found to exist.

The quality of the water brought to the Metropolitan District continues to be satisfactory both in taste and in appearance. This condition results in a large measure from the fact that it is still possible to reject some of the sources which were in use before the extension of the water works to the South Branch of the Nashua River at Clinton. The water derived from the Wachusett watershed has been of superior quality to that coming from the Sudbury and Cochituate sources. The first-named supply, so far as possible, has been that conveyed to the District; the others have been wasted to a greater or less extent as occasion has permitted.

The time, however, is approaching when all the sources will be required for the supply of the District. When that day arrives it will be necessary, without doubt, to filter these inferior waters in order to bring them to the standard of excellence to which the District has become accustomed since the establishment of the Metropolitan water supply.

The subject of adequate filtration has been carefully considered, and whenever the need of such treatment becomes urgent, the Board will be in a position at once to construct the necessary works.

During the year the Board acquired the fee of 30.142 acres of land for the protection and improvement of the water supply.

(5) CLINTON SEWERAGE WORKS.

The Board has maintained and operated since September 15, 1899, works for the disposal of the sewage of the town of Clinton on lands acquired for the purpose in the town of South Lancaster under the authority of chapter 557 of the Acts of the year 1898. By section 3 of this chapter "The metropolitan water board shall maintain and operate the works constructed by it, unless otherwise agreed by said board and the town of Clinton, until the sewage of said town shall have outgrown the normal capacity of the south branch of the Nashua river to properly dispose thereof; and then said board shall transfer to said town all the works, lands, water rights, rights of way, easements and other property constructed and acquired under the provisions hereof, upon such terms as may be agreed upon by said board and said town, and thereafter said works, lands, water

rights, rights of way, easements and other property shall be owned, maintained and operated by the town of Clinton under the supervision and control of the state board of health, and said town shall pay to the Commonwealth for the property so transferred such sum or sums, if any, as may be agreed by said town and said board to be just and proper."

In the opinion of the Board the time is near at hand, if it has not already been reached, when this provision of the statute should become operative. Repeated examinations of the material now treated upon the South Lancaster filter-beds both as to quantity and quality would seem to show that the amount of sewage here treated could not be turned into the South Branch of the Nashua River without producing conditions of serious importance to the inhabitants of the towns on the stream below this point.

(6) FORESTRY.

An area of four acres of the Wachusett Reservoir marginal lands was planted with 3,400 three-year-old pine seedlings from the North Dike nursery, and 9,100 three-year-old white pine seedlings and 1,800 four-year-old white spruce seedlings were planted where previous plantings had failed in West Boylston and Sterling.

Since the beginning of forestal work on Wachusett Reservoir marginal lands 1,424 acres have been planted.

Undesirable trees and other growth of an inferior character have been cut where there was a growth of young white pines from five to eight years old. It has been the policy of the Board to remove, so far as a convenient use of the working force of the department is possible, undesirable trees and underbrush on various portions of the lands controlled by it. In the two nurseries maintained at Oakdale and the North Dike there are at present in good condition 355,040 seedlings.

About 39 acres of Sudbury marginal lands were cleared of trees and brush for planting and on these lands and along the aqueducts and reservoirs 49,500 four-year-old seedlings and 1,400 five to seven-year-old pines from the woods were set out. There are now in the Sudbury nursery 200,000 seedlings which will be ready for transplanting next spring.

The ravages of the gypsy and brown-tail moths and of the elm-leaf beetle and the pine tree weevil have continued during the year,

requiring a large amount of work and considerable expense to protect the trees on lands controlled by the Board. The egg clusters of the gypsy moth have been painted with creosote and nests of the brown-tail moths destroyed by burning, and extensive spraying has been required for the preservation of trees infested by moths and elm-leaf beetles. The pine tree blister has not yet been found on the Wachusett reservoir lands.

(7) WACHUSETT POWER PLANT.

The hydro-electric power station at the Wachusett Dam was operated on 297 days during the year. The daily output varied from the minimum amount which the Connecticut River Transmission Company is required to take under its contract, to the full capacity of the plant. The operation of the plant continues to be successful, the gross earnings for the year being \$34,231.63. The cost of operating the plant has been \$14,633.72, the net earnings \$19,597.91; and the net earnings per thousand kilowatt hours generated, \$3.032.

(8) SUDBURY POWER PLANT.

A portion of the hydro-electric machinery at the Sudbury power station was put into regular service on September 14 and the entire plant has been in service since November 26. The entire output, with the exception of a small amount of energy used for lighting the station and operating the electrically driven accessories has been sold to the Edison Electric Illuminating Company of Boston under a contract dated December 21, 1914. Between September 14, when it was started, and the end of the year the station was operated on 90 days, and since November 26 all of the water discharged from the Sudbury Reservoir has been used for the generation of electric energy. The gross earnings for the portion of the year during which the station was in operation were \$6,663.21, the cost of operating the plant \$3,602.53 and the net earnings \$3,060.68. The net earnings per thousand kilowatt hours generated were \$2.871.

(9) RAINFALL AND WATER SUPPLY.

The rainfall is still below the average, and somewhat less than in the preceding year. On the Wachusett watershed the rainfall was 43.43 inches and on the Sudbury watershed 39.96 inches, while the

averages for the periods covered by the records have been, respectively, 45.30 inches and 44.67 inches.

The Wachusett watershed yielded a daily average of 1,215,000 gallons of water per square mile, and the Sudbury watershed yielded a daily average of 904,000 gallons. The Wachusett watershed has yielded a daily average of 1,073,000 gallons per square mile, for the 20 years during which measurements have been made, and the daily average per square mile from the Sudbury watershed during the 42 years for which records have been kept has been 986,000 gallons.

(10) WATER CONSUMPTION.

During the year the quantity of water supplied to the Metropolitan Water District amounted to a daily average of 106,337,800 gallons, as measured by Metropolitan Water Works meters, which was equivalent to 89 gallons for each person in the District. This quantity was 4,396,300 gallons more than the average daily consumption of the preceding year.

Acting under the authority conferred by several statutes and arrangements which have been made, water has been supplied to a limited extent outside of the Metropolitan Water District. There has been drawn from the open channel of the Wachusett Aqueduct for the use of the Westborough State Hospital a daily average quantity of 172,000 gallons. The town of Framingham has, under the provisions of the statute, drawn indirectly from Farm Pond a daily average quantity of 629,235 gallons and directly from the Sudbury Aqueduct 235,246 gallons. A portion of the town of Saugus has been supplied through the city of Revere with an average of 19,200 gallons daily. The United States Government, for use on Peddock's Island, has been supplied with a daily average of 69,100 gallons. The sums charged for the water thus supplied have amounted to \$6,082.01.

V. WATER WORKS—FINANCIAL STATEMENT.

The financial abstract of the receipts, disbursements, assets and liabilities of the Board for the State fiscal year, beginning with December 1, 1915, and ending with November 30, 1916, was, in accordance with the requirements of chapter 235 of the Acts of the year 1906, presented to the General Court in January last, and a copy of this financial abstract is printed as Appendix No. 5.

As required by said chapter a detailed statement of its doings for the calendar year 1916, in relation to the Metropolitan Water Works, is herewith presented.

CONSTRUCTION.

(1) WATER LOANS — RECEIPTS AND PAYMENTS.

Total loans authorized to January 1, 1917,	\$42,798,000 00	
Receipts from the sales of property applicable to the construction and acquisition of works: —		
For the period prior to January 1, 1916,	\$244,933 56	
For the year ending December 31, 1916,	7,545 23	
		252,478 79
Receipt from the town of Swampscott for admission to District (St. 1909, c. 320),		90,000 00
		<hr/>
Total amount authorized to January 1, 1917,	\$43,140,478 79	
Amounts approved by Board for payments out of Water Loan Fund: —		
Payments prior to January 1, 1916,	\$42,818,170 64	
Approved for year ending December 31, 1916,	105,420 99	
		42,923,591 63
		<hr/>
Amount authorized but not expended January 1, 1917,	\$216,887 16	

(2) TOTAL WATER DEBT, DECEMBER 31, 1916.

Water Loan Outstanding, Sinking Fund and Debt.

Bonds issued by the Treasurer of the Commonwealth: —

Sinking fund bonds (3 and 3½ per cent.),	\$41,398,000 00	
Serial bonds (3½ and 4 per cent.),	1,204,000 00	
		<hr/>
Total bond issue to December 31, 1916,	\$42,602,000 00	
Serial bonds paid prior to January 1, 1916,	\$42,000 00	
Serial bonds paid in 1916,	30,000 00	
		72,000 00
		<hr/>
Total bond issue outstanding December 31, 1916,	\$42,530,000 00	
Gross Water Debt,	\$42,530,000 00	
Sinking fund December 31, 1916,	13,268,199 36	
		<hr/>
Net Water Debt December 31, 1916,	\$29,261,800 64	
A decrease for the year of \$740,954.11.		

(3) METROPOLITAN WATER LOAN AND SINKING FUND,
DECEMBER 31, 1916.

YEAR.	Authorized Loans.	Bonds issued (Sinking Fund).	Bonds issued (Serial Bonds).	Sinking Fund.
1895,	\$27,000,000	\$5,000,000	-	\$226,286 05
1896,	-	2,000,000	-	699,860 70
1897,	-	6,000,000	-	954,469 00
1898,	-	4,000,000	-	1,416,374 29
1899,	-	3,000,000	-	1,349,332 97
1900,	-	1,000,000	-	1,573,619 72
1901,	13,000,000	10,000,000	-	1,662,426 95
1902,	-	3,500,000	-	2,256,803 81
1903,	-	1,500,000	-	2,877,835 59
1904,	-	2,500,000	-	3,519,602 92
1905,	-	650,000	-	4,207,045 69
1906,	500,000	1,350,000	-	4,897,822 62
1907,	-	-	-	5,643,575 69
1908,	398,000	-	-	6,419,283 28
1909,	900,000	398,000	-	7,226,262 31
1910,	80,000	500,000	-	8,089,902 91
1911,	212,000	-	\$200,000	8,953,437 44
1912,	600,000	-	190,000	9,829,356 80
1913,	108,000	-	-	10,767,701 68
1914,	-	-	258,000	11,533,453 45
1915,	-	-	490,000	12,491,245 25
1916,	-	-	66,000	13,268,199 36
	\$42,798,000	\$41,398,000	\$1,204,000	

(4) WATER ASSESSMENT, 1916.

The following water assessment was made by the Treasurer of the Commonwealth upon the various municipalities:—

Sinking fund requirements,	\$261,423 18
Serial bonds,	\$32,000 00
Less premium,	2,096 16
	<hr/> 29,903 84
Interest,	1,461,219 41
Maintenance:—	
Appropriated by Legislature,	\$480,850 00
Less balance on hand,	53,803 84
	<hr/> 427,046 16
Total water assessment for 1916,	\$2,179,592 59

In accordance with chapter 488, Acts of 1895, as amended in 1901, 1904 and 1906, the proportion to be paid by each city and town is based one-third in proportion to their respective valuations and the remaining two-thirds in proportion to their respective water consumption for the preceding year, except that but one-fifth of the total valuation and no consumption has been taken for the city of Newton, as it has not been supplied with water from the Metropolitan Works.

The division of the assessment for 1916 was as follows:—

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$18,118 96	Nahant,	5,324 75
Belmont,	10,143 81	Newton,	6,183 51
Boston,	1,669,432 79	Quincy,	51,468 91
Chelsea,	52,114 06	Revere,	29,548 74
Everett,	48,779 28	Somerville,	110,468 29
Lexington,	8,698 76	Stoneham,	7,506 52
Malden,	47,323 31	Swampscott,	11,937 62
Medford,	28,997 29	Watertown,	21,708 75
Melrose,	18,936 29	Winthrop,	16,026 55
Milton,	16,874 40		\$2,179,592 59

(5) SUPPLYING WATER TO CITIES AND TOWNS OUTSIDE OF DISTRICT AND TO WATER COMPANIES.

Sums having been received during the year 1916 under the provisions of the Metropolitan Water Act, for water furnished, as follows:—

Town of Framingham,	\$1,816 01
City of Revere (on account of water furnished to a portion of the town of Saugus for 1915),	300 00
United States Government (for Peddock's Island),	1,268 97
Westborough State Hospital,	2,320 65
	\$5,705 63

The sums so received prior to March 23, 1907, were annually distributed among the cities and towns of the District; but since that date, in accordance with the provisions of chapter 238 of the Acts of 1907, the sums so received have been paid into the sinking fund.

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1916.
Administration applicable to all parts of the construction and acquisition of the works,	\$5,560 04
Wachusett Department, real estate,	6 50
Wachusett Aqueduct, real estate,	300 00
Power Plant at Sudbury Dam,	46,175 84
Wachusett-Sudbury Power Transmission Line,	1,014 45
Beaver Dam Brook improvement,	1,214 27
Distribution system:—	
Northern high service:—	
Pipe lines and connections,	\$200 00
Northern extra high service:—	
Pipe lines and connections,	202 86
Southern high service:—	
Section 43 (24-inch main in Dorchester through Milton to Quincy),	1,153 19
Southern extra high service:—	
Pipe lines and connections,	15 00
Section 44 (12-inch connection in West Roxbury),	136 59
Bellevue Reservoir on Bellevue Hill in Boston,	16,374 27
Weston Aqueduct supply mains,	26,354 15
Meters and connections,	3,458 18
Real estate,	500 00
	<hr/> 48,394 24
Stock — pipes, valves, castings, etc., purchased and sent first to storage yards, and later transferred, as needed, to the various parts of the work:—	
Amount received,	\$4,133 70
Transferred from storage yards to the various sections of the work and included in costs of special works,	1,378 05
	<hr/> 2,755 65
	<hr/> \$105,420 99
Amount charged from beginning of work to January 1, 1916,	42,818,170 64
	<hr/>
Total for construction and acquisition of works to January 1, 1917,	\$42,923,591 63

MAINTENANCE AND OPERATION.		For the Year ending December 31, 1916.	
Administration,			\$13,358 39
General supervision,			34,122 83
Taxes and other expenses,			42,647 55
Wachusett Department:—			
Superintendence,		\$8,345 46	
Reservoir,		7,146 97	
Forestry,		9,981 23	
Protection of supply,		9,903 30	
Buildings and grounds,		3,207 34	
Wachusett Dam,		5,000 34	
Wachusett Aqueduct,		7,290 21	
Clinton sewerage system:—			
Pumping station,		1,473 83	
Sewers, screens and filter-beds,		5,625 08	
Sanitary inspection,		824 32	
Swamp drainage,		3,298 29	
Power plant,		5,635 16	
Payments under Industrial Accident Law and special benefit appropriations,		59 86	
			67,791 34
Sudbury Department:—			
Superintendence, Framingham office,		\$10,300 77	
Ashland Reservoir,		1,710 25	
Hopkinton Reservoir,		2,478 71	
Whitehall Reservoir,		808 26	
Framingham Reservoirs Nos. 1, 2 and 3,		6,918 78	
Sudbury Reservoir,		17,405 43	
Lake Cochituate,		5,276 34	
Marlborough Brook filters,		3,116 63	
Pegan filters,		3,961 54	
Sudbury and Cochituate watersheds,		1,097 42	
Sanitary inspection,		3,250 85	
Cochituate Aqueduct,		2,609 60	
Sudbury Aqueduct,		5,404 46	
Weston Aqueduct,		5,189 69	
Forestry,		6,229 77	
Payments under Industrial Accident Law and special benefit appropriations,		1,304 49	
Power plant,		2,321 39	
			79,384 38
Distribution Department:—			
Superintendence,		\$5,899 20	
Pumping service:—			
Superintendence,		2,624 49	
Payments under Industrial Accident Law and special benefit appropriations,		536 00	
Arlington pumping station, pumping service,		10,371 88	
Chestnut Hill low-service pumping station, pumping service,		52,085 15	
Chestnut Hill high-service pumping station, pumping service,		11,337 69	
Spot Pond pumping station, pumping service,		14,288 72	
Hyde Park pumping station, pumping service,		7,029 29	
Bear Hill Reservoir,		152 50	
Chestnut Hill Reservoir and grounds,		15,636 05	
Amounts carried forward,		\$119,960 97	\$237,304 49

MAINTENANCE AND OPERATION.	For the Year ending December 31, 1916.	
<i>Amounts brought forward,</i>	\$119,960 97	\$237,304 49
Distribution Department — <i>Con.</i>		
Fells Reservoir,	818 61	
Forbes Hill Reservoir,	1,317 25	
Mystic Lake, conduit and pumping station,	3,496 48	
Mystic Reservoir,	1,037 25	
Arlington standpipe,	27 81	
Waban Hill Reservoir,	244 02	
Weston Reservoir,	4,080 41	
Spot Pond,	10,925 33	
Buildings at Spot Pond,	203 87	
Pipe lines: —		
Low service,	23,796 52	
Northern high service,	5,826 98	
Northern extra high service,	264 21	
Southern high service,	6,483 34	
Southern extra high service,	369 29	
Supply pipe lines,	2,444 91	
Buildings at Chestnut Hill Reservoir,	6,195 27	
Chestnut Hill pipe yard,	1,521 63	
Glenwood pipe yard and buildings,	2,690 58	
Stables,	10,432 09	
Venturi meters,	919 67	
Measurement of water,	1,531 79	
Arlington pumping station, buildings and grounds,	358 53	
Hyde Park pumping station, buildings and grounds,	320 18	
Fisher Hill Reservoir,	2,245 88	
Bellevue Reservoir,	286 20	
Payments under Industrial Accident Law and special benefit appropriations,	681 43	
	208,480 50	
Total for maintaining and operating works,	\$445,784 99	

(7) DETAILED FINANCIAL STATEMENT UNDER METROPOLITAN WATER ACT.

The Board herewith presents, in accordance with the requirements of the Metropolitan Water Act, a detailed statement of the expenditures and disbursements, receipts, assets and liabilities for the year 1916.

(a) *Expenditures and Disbursements.*

The total amount of the expenditures and disbursements on account of construction and acquisition of works for the year beginning January 1, 1916, and ending December 31, 1916, was \$105,420.99, and the total amount from the time of the organization of the Met-

ropolitan Water Board, July 19, 1895, to December 31, 1916, has been \$42,923,591.63.

For maintenance and operation the expenditures for the year were \$445,784.99.

The salaries of the commissioners, and the other expenses of administration, have been apportioned to the construction of the works and to the maintenance and operation of the same, and appear under each of those headings.

The following is a division of the expenditures according to their general character:—

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1916.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING.	
<i>Administration.</i>	
Commissioners,	\$2,432 34
Secretary,	750 00
Clerks and stenographers,	1,780 28
Traveling,	15 00
Stationery and printing,	157 59
Postage, express and telegrams,	35 36
Telephone, lighting, heating, water and care of building,	241 55
Rent and taxes, main office,	146 92
	\$5,560 04
<i>Engineering.</i>	
Chief engineer,	\$17 31
Principal assistant engineers,	2,041 29
Engineering assistants,	3,264 90
Inspectors,	1,266 99
Railroad and street car travel,	215 77
Wagon hire,	244 00
Stationery and printing,	168 05
Postage, express and telegrams,	65
Engineering and drafting supplies,	46 06
Engineering and drafting instruments and tools,	12 30
Books, maps and photographic supplies,	13 45
Telephone, lighting, heating, water and care of buildings:—	
Main office,	724 64
Sub-offices,	17 80
Rent and taxes, main office,	440 78
Unclassified supplies,	60
Miscellaneous expenses,	119 27
	8,593 86
<i>Construction.</i>	
Preliminary work:—	
Advertising,	\$76 64
	76 64
Amount carried forward,	\$14,230 54

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1916.
Amount brought forward,		\$14,230 54
Construction — Con.		
Contracts, Distribution System: —		
Camoia & Williams, laying water pipe on Section 33 northern high-service pipe lines, Contract 308,	\$200 00	
John Cashman & Sons Co., for building masonry tower on Bellevue Hill in Boston, Contract 368,	12,326 54	
Andrew M. Cusack, for laying water pipes on portion of Section 5 of the Weston Aqueduct Supply Mains in Newton, Contract 369,	8,612 88	
Charles A. Kelley, for laying water pipes on portion of Section 5 of the Weston Aqueduct Supply Mains in Newton, Contract 370,	5,715 94	
Builders Iron Foundry, for furnishing Venturi meters and registers, Contract 375,	1,972 00	
Ludlow Valve Mfg. Co., for furnishing check valves, Contract 378,	507 45	
Standard Cast Iron Pipe & Foundry Co., for furnishing special castings, Contract 374,	1,040 40	
Contracts, Power Plant at Sudbury Dam: —		
Lombard Governor Co., for furnishing 3 water wheel governors for use at the Power Plant at Sudbury Dam, Agreement of July 21, 1915,	2,404 00	
The Safety Insulated Wire & Cable Co., for underground cable for Hydro-electric Plant at Sudbury Dam, Contract 373,	1,182 61	
Westinghouse Electric & Mfg. Co., for furnishing and installing Hydro-electric Machinery at Sudbury Dam, Contract 364A,	13,082 72	
S. Morgan Smith Co., for furnishing and installing hydraulic machinery at Sudbury Dam, Contract 364,	11,941 68	
		58,986 22
Additional work: —		
Labor,	\$11,998 97	
Traveling,	48	
Freight and express,	171 61	
Jobbing and repairing,	38 56	
Tools, machinery, appliances and hardware supplies,	1,525 31	
Electrical supplies,	2,263 40	
Castings, ironwork and metals,	902 38	
Iron pipe and valves,	978 90	
Paint and coating,	215 05	
Fuel, oil and waste,	235 14	
Lumber and field buildings,	159 95	
Brick, cement and stone,	502 35	
Sand, gravel and filling,	3 75	
Municipal and corporation work,	11,998 67	
Unclassified supplies,	8 36	
Miscellaneous expenses,	334 59	
		31,337 47
Real Estate.		
Legal and expert: —		
Appraisers,	\$35 00	
Conveyancing supplies,	6 50	
Conveyancing expenses,	25 26	
Amounts carried forward,	\$66 76	\$104,554 23

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1916.	
Amounts brought forward,		\$66 76	\$104,554 23
Real Estate — Con.			
Legal and expert — Con.			
Settlements made by the Board,		300 00	
Judgments,		500 00	
			866 76
			\$105,420 99
Amount charged from beginning of work to January 1, 1916,			42,818,170 64
Total amount of construction expenditures to January 1, 1917,			\$42,923,591 63
MAINTENANCE AND OPERATION OF WORKS.			
Administration: —			
Commissioners,		\$4,841 66	
Secretary and assistants,		5,261 82	
Rent,		701 95	
Repairs of building,		23 52	
Fuel,		84 36	
Lighting,		73 91	
Care of building,		454 99	
Postage,		175 00	
Printing, stationery and office supplies,		1,402 43	
Telephones,		94 60	
Traveling expenses,		113 31	
Miscellaneous expenses,		130 84	
			\$13,358 39
General supervision: —			
Chief engineer and assistants,		\$25,085 02	
Rent,		2,105 95	
Repairs of building,		513 85	
Fuel,		253 14	
Lighting,		221 74	
Care of building,		1,365 15	
Postage,		65 00	
Printing, stationery and office supplies,		850 01	
Telephones,		300 50	
Traveling expenses,		2,434 41	
Miscellaneous expenses,		928 06	
			34,122 83
Pumping service: —			
Superintendence,		\$2,624 49	
Labor,		61,464 92	
Fuel,		29,129 67	
Oil, waste and packing,		1,333 84	
Repairs,		2,233 61	
Small supplies,		950 69	
Payments under Industrial Accident Law and special benefit appropriations,		536 00	
			98,273 22
Amount carried forward,			\$145,754 44

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1916.
<i>Amount brought forward,</i>	\$145,754 44
Reservoirs, aqueducts, pipe lines, buildings and grounds: —	
Superintendents,	\$7,120 00
Engineering assistants,	12,458 30
Sanitary inspectors,	3,267 20
Labor, pay roll,	166,342 89
Labor, miscellaneous,	3,813 00
Alterations and repairs of pumping stations,	339 01
Alterations and repairs of other buildings and structures,	1,154 58
Automobiles,	14,845 20
Brick,	205 93
Brooms, brushes and janitor's supplies,	296 84
Castings, ironwork and metals,	1,914 38
Cement and lime,	1,119 38
Drafting and photo supplies,	249 48
Fertilizer and planting material,	2,064 80
Freight and express,	374 50
Fuel,	2,631 45
Gypsy moth supplies,	2,084 37
Hardware,	1,793 90
Hay and grain,	1,573 90
Lighting,	243 47
Lumber,	1,474 98
Machinery,	811 69
Paints and oils,	1,492 41
Pipe and fittings,	2,346 43
Postage,	104 67
Printing, stationery and office supplies,	872 86
Rubber and oiled goods,	284 13
Stable expenses,	559 87
Sand, gravel and stone,	779 99
Traveling expenses,	2,623 41
Telephones,	1,155 66
Teaming,	4,501 97
Tools and appliances,	2,972 00
Vehicles, harnesses and fittings,	616 28
Miscellaneous expenses,	5,194 15
Contracts: —	
Thomas Russo & Co., Contract 44-M, for constructing surface drains at Spot Pond,	552 48
Coffin Valve Co., Contract 45-M, for furnishing and installing 3 electrically operated sluice gates at Sudbury Dam,	3,983 91
Crowley & Hickey, Contract 50-M, for constructing the superstructure of garage at Chestnut Hill Reservoir,	1,117 75
Payments under Industrial Accident Law and special benefit appropriations,	2,045 78
	257,383 00
Payments in lieu of taxes,	42,647 55
Total expenditures for maintenance and operation,	\$445,784 99

(b) Receipts.

The total amount of receipts from the operations of the Board and from sales of property for the year beginning January 1, 1916, and ending December 31, 1916, was \$60,391.38, and the total amount from the time of the organization of the Metropolitan Water Board, July 19, 1895, to December 31, 1916, has been \$1,312,937.18. The general character of these receipts is as follows:—

GENERAL CHARACTER OF RECEIPTS.	For the Year ending December 31, 1916.
Applicable to the loan fund:—	
Land and buildings,	\$978 00
Construction tools, supplies and reimbursements,	6,567 23
	<hr/> \$7,545 23
Applicable to payment of interest, sinking fund requirements and expenses of maintenance and operation:—	
Proceeds from operations of the Board:—	
Rents,	\$1,798 75
Land products,	3,980 20
Electric energy,	37,136 80
Maintenance labor, tools, supplies and reimbursements,	4,147 06
Interest and unclassified receipts,	77 71
	<hr/> 47,140 52
Applicable to the sinking fund:—	
Water supplied to cities and towns, water companies and others,	5,705 63
	<hr/> \$60,391 38
Amount credited from beginning of work to January 1, 1916,	1,252,545 80
	<hr/>
Total receipts to January 1, 1917,	\$1,312,937 18

The foregoing receipts have been credited to the various objects or works, as follows:—

SOURCES OF RECEIPTS.	For the Year ending December 31, 1916.
Supplying water outside of Water District,	\$5,705 63
Construction and acquisition of works: —	
Administration,	\$25 19
Sudbury Reservoir,	183 50
Distribution system,	6,548 73
Diversion of water, Clinton sewerage system,	803 00
	7,560 42
Maintenance and operation of works: —	
Administration,	\$145 86
General supervision,	250 35
Wachusett Aqueduct,	131 11
Wachusett Reservoir,	3,508 60
Wachusett electric power plant,	32,948 75
Sudbury system,	1,848 01
Sudbury electric power plant,	4,220 55
Distribution system,	2,965 23
Clinton sewerage system,	1,106 87
	47,125 33
	\$60,391 38
Amount credited from beginning of work to January 1, 1916,	1,252,545 80
Total receipts to January 1, 1917,	\$1,312,937 18

(c) *Assets.*

The following is an abstract of the assets of the Water Works, a complete schedule of which is kept on file in the office of the Board: —

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; police supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate and buildings connected therewith.

(d) *Liabilities.*

The sums due on monthly pay rolls amount to \$530.67 and there are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
Joseph Hanreddy,	Contract 314, Section 7 of the Weston Aqueduct Supply Mains.	\$10 00
S. Morgan Smith Co.,	Contract 364, furnishing and installing hydraulic machinery at Sudbury Dam.	1,326 85
Westinghouse Electric & Mfg. Co., .	Contract 364A, furnishing and installing hydro-electric machinery at Sudbury Dam.	2,009 19
Standard Cast Iron Pipe & Foundry Co.	Contract 374, furnishing special castings, . .	183 60
Builders Iron Foundry,	Contract 375, furnishing Venturi meters and registers.	348 00
Ludlow Valve Mfg. Co.,	Contract 378, furnishing check valves, . .	89 55
Crowley & Hickey,	Contract 50-M, constructing the superstructure of garage at Chestnut Hill Reservoir.	197 25

Claims have been made by the following parties for land taken:—
Town of Framingham, William H. Buck, heirs of Harrison Eames,
Lizzie W. Sampson, Nahum F. Brewer, Michael Bishley.

VI. METROPOLITAN SEWERAGE WORKS.

The North Metropolitan Sewerage District embraces the cities of Cambridge, Chelsea, Everett, Malden, Medford, Melrose, Revere, Somerville and Woburn, and the towns of Arlington, Belmont, Reading, Stoneham, Wakefield, Winchester and Winthrop and parts of the city of Boston and the town of Lexington, — comprising in all 10 cities and 8 towns, with an area of 100.32 square miles. The district has an estimated population, based upon the census of 1915, as of December 31, 1916, of 620,070. Of the total population it is estimated that 89.9 per cent., or 557,160 people, contribute sewage to the North Metropolitan System.

The South Metropolitan Sewerage District includes the cities of Newton, Quincy and Waltham, and the towns of Brookline, Milton, Watertown and Wellesley, and parts of the city of Boston and the town of Dedham, — a total of 4 cities and 5 towns. This district has an area of 110.76 square miles, with an estimated population as of December 31, 1916, of 455,630. According to the estimates made 69.6 per cent. of this population, or 317,005, contribute sewage to the South Metropolitan System.

(1) NORTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the North Metropolitan System during the past year was \$131,064.39.

Work has been carried on in the construction of the extension of the Deer Island outfall, authorized by chapter 344 of the Acts of 1914. The progress of this work has been largely controlled by the weather conditions at this exposed headland, but with a favorable season it is probable that the new outlet will be ready for service before the end of the year, and a substantial even if not complete relief will be obtained from the increasingly offensive discharge of sewage at this point. The success which has been obtained at the deep water outlets for sewage near Peddock's Island gives assurance of equally good results here.

The Board was directed by chapter 215 of the General Acts of 1915 to lower the Metropolitan sewerage siphon under Malden River so as to dredge a river channel of greater depth than is possible with the sewer at its then existing level. After consultation with the Port Directors it was decided to lower the siphon to a level which would make possible a channel 20 feet deep. This work has been successfully completed.

By chapter 159 of the General Acts of 1916 the town of Reading was admitted to the North Metropolitan Sewerage District. Surveys have been made for the extension of the North Metropolitan Sewer to this town and the Board is prepared to proceed with the work when satisfactory contracts can be made. It is hoped that it may be possible to proceed with the construction of this extension during the present year.

(2) NORTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The cost of the maintenance and operation of the North Metropolitan System during the past year was \$179,784.85.

Sewers and Pumping Stations.

The Metropolitan sewers in the North Metropolitan System now extend a distance of 63.902 miles, and the local sewers which are connected with the Metropolitan sewers have a further length of 761.76 miles, involving 82,916 connections.

The sewage of the North Metropolitan District flows at first by

gravity, but before being finally disposed of is lifted at different points by pumping and is finally discharged into the harbor from an outfall off Deer Island.

The daily average amount of sewage discharged into the harbor was 66,300,000 gallons, a daily average for each person contributing sewage of 119 gallons. The increase in the total amount of sewage discharged was 5,908,000 gallons per day more than the discharge of the preceding year. The maximum rate of discharge in any one day was 157,300,000 gallons.

The pumping stations operated for the North Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Deer Island station (Boston harbor),	4	235,000,000	19
East Boston station,	4	235,000,000	19
Charlestown station,	3	104,000,000	{ 11 8
Alewife Brook station (Somerville),	3	22,000,000	13

There were purchased for the operation of the pumping stations 7,533 tons of bituminous coal, the average prices of which, at the different stations, varied from \$4.55 to \$5.85 per gross ton delivered in the bins.

The amount expended for the stations was \$116,671.49. The average cost per million gallons of sewage lifted per foot at the several stations was \$0.131, a decrease of 3 per cent. from the cost last year.

(3) SOUTH METROPOLITAN SEWERAGE SYSTEM — CONSTRUCTION.

The amount expended for construction on account of the South Metropolitan System during the past year was \$175,383.44.

The town of Wellesley was admitted to the South Metropolitan Sewerage District by chapter 343 of the Acts of 1914, and the act was accepted by the town in March, 1915.

The necessary surveys were at once undertaken and as soon as possible contracts were awarded for four sections out of the nine into which the sewer was divided. At the end of the year these

four sections have been completed and work is in progress on two other sections. If the additional appropriation requested is authorized by the Legislature of the present year the three remaining sections of this sewer will be placed under contract at a date early enough to permit the completion of the whole line down to the connection with the main sewer in West Roxbury in the season of 1918.

The original estimate for the construction of the Wellesley extension, High-level sewer, of \$350,000 was made by the State Board of Health, and was based on a report submitted by an engineer called in by that Department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing Metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street which is a part of the Metropolitan District and has no possible means of reaching the Metropolitan System excepting by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health. This is somewhat longer but reaches the existing Metropolitan sewer at a point where the latter is of increased size and at the same time furnishes a means of outlet for the above-named portion of Dedham and obviates the difficulties in connection with our construction in the fields of the Brookline Water Works.

The Board has also designed a sewer of considerably larger capacity than was anticipated by the State Board of Health, feeling that the same is justified by the future demands of the District.

The line adopted has a length of about 40,000 feet almost wholly through private lands. The natural physical conditions in this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, it is necessary that an additional appropriation be asked for to complete the work.

The Board acquired by taking, during the year, easements in 6.925 acres of land in Dedham, Needham and West Roxbury for the construction of the Wellesley extension of the High-level sewer.

(4) SOUTH METROPOLITAN SEWERAGE SYSTEM — MAINTENANCE.

The entire cost of maintenance of the South Metropolitan System during the past year was \$114,975.93.

Sewers and Pumping Stations.

The Metropolitan sewers in the South Metropolitan System, which comprise the old Charles River valley sewer and Neponset River valley sewer, as well as the new High-level sewer and extensions, have a total length of 47.582 miles, and with these are connected local sewers having a length of 641.31 miles, involving 43,994 connections.

The pumping stations operated for the South Metropolitan Sewerage System are as follows: —

	Number of Engines.	Contract Capacity per Day (Gallons).	Lift (Feet).
Ward Street station (Roxbury District),	2	100,000,000	45
Quincy station,	3	18,000,000	28
Quincy sewerage lifting station,	2	3,000,000	20

The sewage of two small areas in Dorchester and Milton, included in the Neponset River valley system, which are too low for sewage to be delivered into the High-level sewer by gravity, is, under an arrangement with the city of Boston, disposed of through the Boston Main Drainage Works at Moon Island. By this arrangement the Board is relieved from the expense of providing extra pumping facilities.

A large part of the sewage of the South District is lifted into the High-level sewer at the Ward Street pumping station in Roxbury. Most of the sewage of the city of Quincy is pumped into the High-level sewer at Greenleaf Street near the Quincy pumping station. All of the sewage of the South District is screened at the Nut Island screen-house for the purpose of intercepting solid matter, and is thence discharged at the bottom of the harbor from the outfalls about a mile off the island.

The daily average amount of sewage thus discharged was 62,000,000 gallons, and the largest rate of discharge in a single day was during a heavy storm, when the amount reached 178,000,000 gallons. The increase in the daily average from last year was 9,700,000 gallons. The daily average discharge of sewage for each individual contributing sewage in the district was 196 gallons.

There were 3,753 gross tons of bituminous coal purchased at the two pumping stations and the screen-house, the average prices of which varied from \$5.21 to \$5.87 per gross ton delivered in the bins.

The total amount expended for the operation of the stations was \$70,233.79.

VII. SEWERAGE WORKS — FINANCIAL STATEMENT.

The financial abstract of the receipts, expenditures, disbursements, assets and liabilities of the Metropolitan Water and Sewerage Board for the fiscal year of the Commonwealth ending with November 30, 1916 was, as stated in connection with the Water Works, presented to the General Court in January, in accordance with the requirements of chapter 235 of the Acts of the year 1906, and a copy of this financial abstract is in part printed as Appendix No. 5.

The following statement of its financial doings, in relation to the Metropolitan Sewerage Works, for the calendar year 1916 is herewith presented, in accordance with the provisions of the act of 1906, as a part of the annual report of the Board.

(1) METROPOLITAN SEWERAGE LOANS, RECEIPTS AND PAYMENTS.

The loans authorized for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of these loans, the expenditures for construction, and the balances available on January 1, 1917, have been as follows: —

North Metropolitan System.

Loans authorized under various acts prior to 1916 for the construction of the North Metropolitan System and the various extensions,	\$7,227,365 73
Loan authorized under General Acts of 1916: —	
Chapter 159 (Reading Extension),	285,000 00
Receipts from sales of real estate and from miscellaneous sources which are placed to the credit of the North Metropolitan System: —	
For the year ending December 31, 1916,	\$201 32
For the period prior to January 1, 1916,	85,516 79
	<hr/>
	85,718 11
	<hr/>
	\$7,598,083 84

Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System: —

For the year ending December 31, 1916,	\$131,064 39
For the period prior to January 1, 1916,	7,125,637 95
	<hr/>
	7,256,702 34

Balance, North Metropolitan System, January 1, 1917, . . . \$341,381 50

South Metropolitan System.

Loans authorized under the various acts, prior to 1916, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions, constituting the South Metropolitan System,	\$9,222,046 27
Loan authorized under General Acts of 1916: —	
Chapter 93 (Additions to Ward St. Pumping Station Plant).	40,000 00
Receipts from pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —	
For the year ending December 31, 1916,	\$230 31
For the period prior to January 1, 1916,	19,070 14
	<hr/>
	19,300 45
	<hr/>
	\$9,281,346 72

Amount carried forward, \$9,281,346 72

¹ The word "Board" refers to the Metropolitan Sewerage Commission and the Metropolitan Water and Sewerage Board.

<i>Amount brought forward,</i>		\$9,281,346 72
Amount approved by the Board for payment out of the Metropolitan Sewerage Loan Fund, South System:—		
On account of the Charles River valley sewer,	\$800,046 27	
On account of the Neponset valley sewer,	911,531 46	
On account of the High-level sewer and extensions, including Wellesley extension:—		
For the year ending December		
31, 1916,	\$175,383 44	
For the period prior to January		
1, 1916,	7,232,020 41	
	<hr/>	7,407,403 85
		<hr/>
		9,118,981 58
Balance, South Metropolitan System, January 1, 1917,		\$162,365 14

(2) TOTAL SEWERAGE DEBT, DECEMBER 31, 1916.

North Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$6,563,000 00
Serial bonds (3½ and 4 per cent.),	640,500 00
	<hr/>
Total bond issue to December 31, 1916,	\$7,203,500 00
Serial bonds paid prior to January 1, 1916,	\$29,000 00
Serial bonds paid in 1916,	19,500 00
	<hr/>
	48,500 00
Total bond issue outstanding December 31, 1916,	\$7,155,000 00

Gross Sewerage Debt,	\$7,155,000 00
Sinking fund December 31, 1916,	2,284,055 75
	<hr/>

Net Sewerage Debt December 31, 1916,	\$4,870,944 25
A decrease for the year of \$138,045.89.	

South Metropolitan System.

Bonds issued by the Treasurer of the Commonwealth:—

Sinking fund bonds (3 and 3½ per cent.),	\$8,877,912 00
Serial bonds,	355,000 00
	<hr/>
Total bond issue to December 31, 1916,	\$9,232,912 00
Gross Sewerage Debt,	\$9,232,912 00
Sinking fund December 31, 1916,	1,320,601 52
	<hr/>
Net Sewerage Debt December 31, 1916,	\$7,912,310 48
A net increase for the year of \$219,868.08.	

(3) NORTH AND SOUTH METROPOLITAN LOAN AND SINKING FUNDS,
DECEMBER 31, 1916.

YEAR.	LOANS.		BONDS ISSUED (SINKING FUND).		BONDS ISSUED (SERIAL BONDS).		SINKING FUND.
	North System.	South System.	North System.	South System.	North System.	South System.	North and South Systems.
1889, . . .	\$5,000,000 00	-	-	-	-	-	-
1890, . . .	-	-	\$2,200,000	\$800,000	-	-	-
1891, . . .	-	-	368,000	-	-	-	-
1892, . . .	-	-	1,053,000	-	-	-	-
1893, . . .	-	-	579,000	-	-	-	-
1894, . . .	500,000 00	-	500,000	-	-	-	-
1895, . . .	300,000 00	\$500,000 00	300,000	300,000	-	-	-
1896, . . .	30,000 00	-	30,000	200,000	-	-	-
1897, . . .	85,000 00	300,000 00	80,000	300,000	-	-	-
1898, . . .	215,000 00	35,000 00	220,000	35,000	-	-	-
1899, . . .	-	4,625,000 00	-	1,025,000	-	-	\$361,416 59
1900, . . .	265,000 00	10,912 00 ¹	265,000	10,912	-	-	454,520 57
1901, . . .	-	40,000 00	-	2,040,000	-	-	545,668 26
1902, . . .	-	-	-	864,000	-	-	636,084 04
1903, . . .	500,000 00	1,000,000 00	500,000	1,736,000	-	-	754,690 41
1904, . . .	-	392,000 00	-	392,000	-	-	878,557 12
1905, . . .	-	-	-	-	-	-	1,008,724 95
1906, . . .	55,000 00	1,175,000 00	55,000	175,000	-	-	1,146,998 68
1907, . . .	-	-	-	300,000	-	-	1,306,850 30
1908, . . .	413,000 00	-	-	700,000	-	-	1,492,418 98
1909, . . .	-	-	300,000	-	-	-	1,672,784 40
1910, . . .	56,000 00	-	113,000	-	-	-	1,931,741 89
1911, . . .	6,000 00	-	-	-	-	-	2,184,674 98
1912, . . .	378,000 00	-	-	-	\$62,000	-	2,458,541 20
1913, . . .	-	-	-	-	378,000	-	2,749,337 90
1914, . . .	130,500 00	-	-	-	-	-	3,011,512 44
1915, . . .	83,000 00	-	-	-	130,500	-	3,290,979 46
1916, . . .	285,000 00	40,000 00	-	-	70,000	\$355,000	3,604,657 27
	\$8,301,500 00 ²	\$8,472,912 09	-	-	-	-	-
	789,134 27	789,134 27	-	-	-	-	-
	\$7,512,365 73	\$9,262,046 27	\$6,563,000	\$9,877,912	\$640,500	\$355,000	-

¹ The sum of \$10,912 was appropriated to reimburse the town of Watertown for the expense of constructing the Watertown siphon.

² Of this amount \$789,134.27 was expended for the construction of the Charles River valley sewer, which is now included in the South Metropolitan System.

(4) ANNUAL APPROPRIATIONS, RECEIPTS AND EXPENDITURES.

The annual appropriations for the maintenance of the Metropolitan Sewerage Works, the receipts of the Board which are added to the appropriations for maintenance, and the expenditures for maintenance for the year ending December 31, 1916, were as follows: —

North Metropolitan System.

Appropriation as follows: —

Chapter 167, Special Acts of 1916,	\$180,000 00
Receipts from pumping and from other sources,	1,961 37
	<hr/>
	\$181,961 37
Amount approved by the Board for payment,	179,784 85
	<hr/>
Balance, January 1, 1917,	\$2,176 52

South Metropolitan System.

Appropriation as follows: —

Chapter 168, Special Acts of 1916,	\$115,000 00
Receipts from pumping and from other sources,	527 83
	<hr/>
	\$115,527 83
Amount approved by the Board for payment,	114,975 93
	<hr/>
Balance, January 1, 1917,	\$551 90

(5) SEWER ASSESSMENTS, 1916.

The following sewer assessments were made by the Treasurer of the Commonwealth upon the various municipalities: —

North Metropolitan Sewerage System.

Sinking fund requirements,	\$110,165 52
Serial bonds,	13,776 80
Interest,	223,534 15
Maintenance: —	
Appropriated by Legislature,	\$180,000 00
Less balance on hand,	27,059 76
	<hr/>
	152,940 24
	<hr/>
Total North Metropolitan sewerage assessment,	\$500,416 71

South Metropolitan Sewerage System.

Sinking fund requirements,	\$73,654 37
Interest,	310,996 95
Maintenance:—	
Appropriated by Legislature,	\$115,000 00
Less balance on hand,	9,167 38
	<hr/> 105,832 62
Total South Metropolitan sewerage assessment,	<hr/> \$490,483 94

In accordance with the provisions of chapter 369, Acts of 1906, the proportion to be paid by each city and town to meet the interest and sinking fund requirements for each year is based upon their respective taxable valuations, and to meet the cost of maintenance and operation upon their respective populations.

The divisions of the assessments for 1916 were as follows:—

North Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Arlington,	\$14,903 84	Melrose,	\$16,153 54
Belmont,	9,705 02	Revere,	19,804 14
Boston,	77,649 17	Somerville,	67,511 00
Cambridge,	109,283 75	Stoneham,	5,486 60
Chelsea,	29,394 67	Wakefield,	10,720 06
Everett,	29,092 57	Winchester,	13,892 93
Lexington,	5,194 42	Winthrop,	12,993 10
Malden,	39,086 96	Woburn,	13,112 39
Medford,	26,427 50	Total,	\$500,416 71

South Metropolitan Sewerage System.

CITIES AND TOWNS.	Assessment.	CITIES AND TOWNS.	Assessment.
Boston,	\$220,679 98	Quincy,	\$32,951 65
Brookline,	95,105 55	Waltham,	24,241 78
Dedham,	11,116 91	Watertown,	15,727 66
Milton,	20,839 61	Wellesley,	10,770 24
Newton,	59,050 56	Total,	\$490,483 94

(6) EXPENDITURES FOR THE DIFFERENT WORKS.

The following is a summary of the expenditures made in the various operations for the different works:—

CONSTRUCTION AND ACQUISITION OF WORKS.	For the Year ending December 31, 1916.
<i>North Metropolitan System.</i>	
North System, enlargement:—	
Administration,	\$2,476 50
New Mystic sewer,	2,237 49
Section 57A, Revere extension,	15 85
Deer Island Outfall extension,	84,139 60
Malden River siphon, Section 19,	30,429 81
Removal of old Malden River siphon,	7,625 86
Reading extension,	4,139 23
	\$131,064 39
Amount charged from beginning of work to January 1, 1916,	7,125,637 95
Total for North Metropolitan System to January 1, 1917,	\$7,256,702 34
<i>South Metropolitan System.</i>	
High-level sewer,	\$30 00
High-level sewer extensions:—	
Administration,	\$3,705 34
Relief Outfall, Section 43,	5,055 85
Wellesley extension:—	
Section 98,	\$11,883 83
Section 99,	2,388 68
Section 100,	967 29
Section 101,	527 45
Section 102,	16,714 45
Section 103,	37,418 46
Section 104,	63,539 07
Section 105,	9,493 78
Section 106,	23,263 33
Legal, etc.,	302 77
	166,499 11
Additions to Ward Street pumping station plant,	93 14
	175,353 44
	\$175,383 44
Amount charged from beginning of work to January 1, 1916,	8,943,598 14
Total for South Metropolitan System to January 1, 1917,	\$9,118,981 58
Total for construction, both systems,	\$16,375,683 92
MAINTENANCE AND OPERATION.	For the Year ending December 31, 1916.
North Metropolitan System,	\$179,784 85
South Metropolitan System,	114,975 93
Total for maintenance, both systems,	\$294,760 78

(7) DETAILED FINANCIAL STATEMENT.

The Board herewith presents, in accordance with the Metropolitan Sewerage acts, an abstract of the expenditures and disbursements, receipts, assets and liabilities for the year ending December 31, 1916:—

(a) *Expenditures and Disbursements.*

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1916.
CONSTRUCTION OF WORKS AND ACQUISITION BY PURCHASE OR TAKING. <i>North System Enlargement.</i>	
Administration:—	
Commissioners,	\$966 66
Secretary,	375 00
Clerks and stenographers,	716 97
Traveling expenses,	57
Stationery, printing and office supplies,	168 44
Telephone, lighting, heating, water and care of building,	134 59
Rent and taxes, main office,	114 27
	\$2,476 50
Engineering:—	
Chief engineer,	\$1,875 00
Engineering assistants,	6,367 49
Inspectors,	3,351 05
Traveling expenses,	557 05
Stationery, printing and office supplies,	200 41
Engineering and drafting instruments and tools,	107 18
Engineering and drafting supplies,	64 84
Telephone, lighting, heating, water and care of building,	403 85
Rent and taxes,	342 83
Miscellaneous expenses,	106 95
	13,376 65
Advertising,	\$63 00
Labor and teaming,	2,801 25
Tools, machinery and appliances,	396 91
Brick, cement, lumber and other field supplies and expenses,	4,215 70
	7,476 86
Contracts:—	
Boston Dredging Co., Contract 137, for removal of old Malden River siphon between Everett and Medford,	\$6,950 00
George M. Bryne, Contract 132, for reconstruction of Malden River siphon between Everett and Medford,	26,039 85
George M. Bryne, Contract 131, for constructing Section 1A of the Deer Island Temporary Outfall extension,	34,912 92
United States Cast Iron Pipe and Foundry Co., Contract 130, for furnishing castings for the Deer Island Outfall sewer extension in Boston Harbor,	17,245 98
Roy H. Beattie Inc., Contract 135, for constructing Section 1 of the Deer Island Outfall sewer extension in Boston Harbor,	20,540 42
	105,689 17
Real estate:—	
Legal, conveyancing and expert,	\$45 21
Settlements,	2,000 00
	2,045 21
Total for North Metropolitan System,	\$131,064 39

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1916.
<i>South Metropolitan System.</i>	
<i>High-level Sewer.</i>	
Engineering:—	
Rent of office, Ashburton Place,	\$30 00
	\$30 00
<i>High-level Sewer Extensions.</i>	
Administration:—	
Commissioners,	\$1,416 67
Secretary,	375 00
Clerks and stenographers,	1,238 63
Traveling expenses,	27 85
Stationery, printing and office supplies,	288 42
Telephone, lighting, heating, water and care of building,	193 04
Rent and taxes, main office,	155 73
Miscellaneous expenses,	10 00
	3,705 34
Engineering:—	
Chief engineer,	\$750 00
Engineering assistants,	9,905 79
Inspectors,	7,233 82
Traveling expenses,	725 19
Engineering and drafting instruments and tools,	175 34
Stationery, printing and office supplies,	712 76
Engineering and drafting supplies,	166 70
Telephone, lighting, heating, water and care of building,	579 22
Rent and taxes, main office,	467 23
Miscellaneous expenses,	572 74
	21,288 79
Advertising,	\$195 81
Labor and teaming,	3,699 44
Tools, machinery and appliances,	426 83
Brick, cement, lumber and other field supplies and expenses,	5,931 66
	10,253 74
Contracts:—	
W. H. Ellis & Son Co., Contract 120, for constructing part of Section 43, Relief Outfall line of the High-level sewer in Boston Harbor,	\$5,055 85
Hugh Nawn Contracting Co., Contract 123, for constructing Section 106 of the High-level sewer (Wellesley extension) in Needham,	20,488 05
Hugh Nawn Contracting Co., Contract 124, for constructing Section 105 of the High-level sewer (Wellesley extension) in Needham,	11,665 09
Bay State Dredging and Contracting Co., Contract 133, for constructing Section 104 of the High-level sewer (Wellesley extension) in Needham,	51,447 48
Bruno & Petitti, Contract 134, for constructing Section 103 of the High-level sewer (Wellesley extension) in Needham,	31,173 72
Bruno & Petitti, Contract 143, for constructing Section 102 of the High-level sewer (Wellesley extension) in Needham,	13,186 47
George M. Byrne, under agreement dated October 23, 1916, for constructing Section 98 of the High-level sewer (Wellesley extension) in West Rox- bury and Dedham,	6,786 14
	139,802 80
Real estate:—	
Legal, conveyancing and expert,	302 77
Total for South Metropolitan System,	\$175,383 44

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1916.	
MAINTENANCE AND OPERATION OF WORKS. <i>North Metropolitan System.</i>			
Administration: —			
Commissioners,		\$2,533	34
Secretary and assistants,		2,789	50
Rent,		293	85
Heating, lighting and care of building,		289	84
Repairs of building,		3	02
Postage,		40	00
Printing, stationery and office supplies,		516	12
Telephones,		47	64
Traveling expenses,		50	00
Miscellaneous expenses,		46	90
			\$6,610 21
General supervision: —			
Chief engineer and assistants,		\$4,514	59
Rent,		881	55
Heating, lighting and care of building,		869	62
Repairs of building,		9	08
Postage,		20	00
Printing, stationery and office supplies,		148	11
Telephones,		142	94
Traveling expenses,		125	00
			6,710 89
Deer Island pumping station: —			
Labor,		\$20,068	00
Fuel,		16,618	91
Oil and waste,		466	12
Water,		1,291	20
Packing,		140	16
Repairs and renewals,		1,198	53
Telephones,		25	85
General supplies,		583	67
Miscellaneous supplies and expenses,		441	88
			40,834 32
East Boston pumping station: —			
Labor,		\$20,453	27
Fuel,		13,843	92
Oil and waste,		520	23
Water,		1,727	20
Packing,		67	77
Repairs and renewals,		1,177	23
Telephones,		5	80
General supplies,		573	52
Miscellaneous supplies and expenses,		432	53
			38,801 47
Charlestown pumping station: —			
Labor,		\$17,105	67
Fuel,		5,890	02
Oil and waste,		226	91
Water,		513	60
Amounts carried forward,		\$23,736	20
			\$92,956 89

GENERAL CHARACTER OF EXPENDITURES.	For the Year ending December 31, 1916.	
<i>Amounts brought forward,</i>	\$23,736 20	\$92,956 89
<i>North Metropolitan System — Con.</i>		
Charlestown pumping station — <i>Con.</i>		
Packing,	36 30	
Repairs and renewals,	243 48	
Telephones,	60 75	
General supplies,	231 85	
Miscellaneous supplies and expenses,	294 68	
		24,603 26
Alewife Brook pumping station: —		
Labor,	\$3,741 22	
Fuel,	2,929 46	
Oil and waste,	223 18	
Water,	245 04	
Packing,	16 03	
Repairs and renewals,	47 06	
Telephones,	47 71	
General supplies,	112 72	
Miscellaneous supplies and expenses,	70 02	
		12,432 44
Sewer lines, buildings and grounds: —		
Engineering assistants,	\$2,475 00	
Labor,	33,313 29	
Brick, cement and lime,	285 30	
Castings, ironwork and metals,	329 17	
Fuel and lighting,	90 33	
Jobbing and repairing,	326 26	
Lumber,	939 80	
Machinery, tools and appliances,	1,284 55	
Paints and oils,	523 29	
Rubber and oiled goods,	343 06	
Sand, gravel and stone,	288 17	
Telephones,	70 49	
Traveling expenses,	369 60	
General supplies,	1,100 64	
Miscellaneous expenses,	347 90	
		42,136 85
Horses, vehicles and stable account,		4,554 41
Payments under Industrial Accident Law and special benefit appropriations,		3,101 00
Total for North Metropolitan System,		\$179,784 85

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1916.
<i>South Metropolitan System.</i>		
Administration:—		
Commissioners,	\$1,808 33	
Secretary and assistants,	2,044 94	
Rent,	212 21	
Heating, lighting and care of building,	173 74	
Postage,	40 00	
Printing, stationery and office supplies,	458 83	
Telephones,	26 12	
Traveling expenses,	38 50	
Miscellaneous expenses,	44 20	
		\$4,846 87
General supervision:—		
Chief engineer and assistants,	\$4,854 66	
Rent,	636 69	
Heating, lighting and care of building,	521 35	
Printing, stationery and office supplies,	305 73	
Telephones,	78 36	
Traveling expenses,	50 00	
Miscellaneous expenses,	18 00	
		6,464 79
Ward Street pumping station:—		
Labor,	\$22,012 59	
Fuel,	11,742 83	
Oil and waste,	301 83	
Water,	1,490 40	
Packing,	245 18	
Repairs and renewals,	4,064 68	
Telephones,	38 24	
General supplies,	1,099 12	
Miscellaneous supplies and expenses,	365 32	
		41,360 19
Quincy pumping station:—		
Labor,	\$8,340 39	
Fuel,	5,069 70	
Oil and waste,	71 24	
Water,	298 95	
Packing,	40 51	
Repairs and renewals,	362 89	
Telephones,	46 40	
General supplies,	331 68	
Miscellaneous supplies and expenses,	43 09	
		14,604 85
Nut Island screen-house:—		
Labor,	\$8,710 04	
Fuel,	4,006 46	
Oil and waste,	90 79	
Water,	439 26	
Packing,	54 28	
Repairs and renewals,	70 32	
Amounts carried forward,	\$13,421 15	\$67,276 70

GENERAL CHARACTER OF EXPENDITURES.		For the Year ending December 31, 1916.	
<i>Amounts brought forward,</i>		\$13,421 15	\$67,276 70
<i>South Metropolitan System — Con.</i>			
Nut Island screen-house — <i>Con.</i>			
Telephones,		58 65	
General supplies,		628 14	
Miscellaneous supplies and expenses,		160 81	
			14,268 75
Sewer lines, buildings and grounds: —			
Engineering assistants,		\$3,375 00	
Labor,		17,776 62	
Automobiles,		471 55	
Brick, cement and lime,		27 91	
Castings, ironwork and metals,		39 91	
Fuel and lighting,		95 75	
Jobbing and repairing,		357 37	
Lumber,		525 96	
Machinery, tools and appliances,		70 80	
Paints and oils,		104 72	
Rubber and oiled goods,		115 88	
Sand, gravel and stone,		40 07	
Telephones,		42 55	
Traveling expenses,		204 50	
General supplies,		263 17	
Miscellaneous expenses,		355 10	
			23,866 86
City of Boston, for pumping and interest,			6,423 73
Horses, vehicles and stable account,			3,139 89
Total for South Metropolitan System,			\$114,975 93

(b) Receipts.

The receipts from the sales of property, from rents and from other sources, have been credited as follows: —

ACCOUNT.	For the Year ending December 31, 1916.
Construction: —	
North Metropolitan System,	\$201 32
South Metropolitan System,	230 31
Maintenance: —	
North Metropolitan System,	1,961 37
South Metropolitan System,	527 83
	\$2,920 83
Amount credited from beginning of work to January 1, 1916,	126,723 27
Total receipts to January 1, 1917,	\$129,649 10

(c) *Assets.*

The following is an abstract of the assets of the Sewerage Works, a complete schedule of which is kept on file in the office of the Board:—

Office furniture, fixtures and supplies; engineering and scientific instruments and supplies; horses, vehicles, field machinery, etc.; machinery, tools and other appliances and supplies; completed works, real estate connected therewith.

(d) *Liabilities.*

There are bills for current expenses which have not yet been received.

Amounts on Monthly Estimates, not due until Completion of Contracts or until Claims are settled.

NAME.	Work.	Amount.
High-level sewer:—		
National Contracting Co., . . .	Section 73, Contract abandoned,	\$5,516 17 ¹
High-level sewer extensions:—		
Timothy J. O'Connell,	Contract 57, Section 82, in part,	60 00
W. H. Ellis & Son Co.,	Contract 120, Section 43, in part, Relief Outfall line,	200 00
Bruno & Petitti,	Contract 134, Section 103, Wellesley extension, .	5,501 25
Bay State Dredging and Contracting Co.	Contract 133, Section 104, Wellesley extension, .	3,196 61
Bruno & Petitti,	Contract 143, Section 102, Wellesley extension, .	2,327 03
North System enlargement:—		
George M. Bryne,	Contract 131, Section 1A, Deer Island Temporary Outfall.	6,655 09
Roy H. Beattie, Inc.,	Contract 135, Section 1, Deer Island Outfall extension.	3,624 78

¹ Damages claimed by the Commonwealth on account of the abandonment of the contract exceed this amount.

Settlements are pending with the following parties for easements taken in lands owned by them:—

Isabella P. Shaw, Arthur W. Pope, F. Murray Forbes, Hugh D. Scott, Mabel H. Foster, Walker-Gordon Laboratory Co., Charles H. Harmon, New York, New Haven & Hartford Railroad, heirs of John Defren, J. W. Battelle, Clifford M. Locke, Martha W. Burrage, Quinobequin Canoe Association, Needham Tire Co., Anne B. Richardson, Leslie B. Cutler, Anne Williams, John Wells Farley,

I. Tucker Burr, Jr., Edward and Catherine Bingham, Hannah Bingham, Katherine H. Rooney, Mary A. Read, J. Austin Amory, Hannah E. Pond, Richard G. Wadsworth, Charles Philip Beebe, John T. Morse, Jr., Mary A. Sidney, Frank P. Chase.

VIII. RECOMMENDATIONS FOR LEGISLATION.

In the abstract of the annual report for the year 1916 the Board made the following statement and recommendations:—

On account of the high price of labor and materials, resulting from the unusual business conditions that have prevailed during the past year, a large portion of the construction work already authorized has been deferred with the hope of carrying out the projects under more favorable conditions.

Plans and specifications were prepared and proposals were received on July 24 for the work of improving Beaver Dam Brook. As the lowest bid received for this work was \$49,732.50, or about \$18,000 in excess of the funds available for the project, the proposals were all rejected. If this work is to be done during the present year an additional appropriation of at least \$30,000 should be made to cover the expense.

On June 9 bids were received for the cast-iron water pipes and specials required for the proposed extensions of the Distribution System for the Lexington and Milton extra high services and for the proposed connections and relocation of meters in Brookline and Somerville, but on account of the high prices, only the materials required for the work in connection with the relocation of the meters were purchased. A portion of this work for which the materials were purchased was done during the year and it is the intention to complete it early in 1917.

If the proposed extensions of the Distribution System for the Lexington and Milton extra high services are made this year it is very probable that the cost will exceed the amount appropriated for the work, but it does not appear to be feasible accurately to estimate the probable cost of the work in advance of the receipt of actual proposals.

The amount appropriated for the construction of the Wachusett-Sudbury transmission line is not sufficient to cover the cost of construction at the prevailing prices, but under the agreement which has been made for the sale of the electric energy at the Wachusett power station the construction of the transmission line can be deferred until next year.

During the past year the question of abandoning the East Boston reservoir and using the land for park purposes has been seriously considered by the City of Boston. If this action should be authorized by the city government it would, in the opinion of the Board, be desirable to lay a new 36-inch main about 1,800 feet in length in Chelsea to reinforce the existing East Boston supply main before the reservoir is abandoned. The estimated cost of this line was \$18,000 in 1915. If this line is to be constructed this year an appropriation of at least \$25,000 should be available for the purpose.

There is a balance of \$46,000 now remaining from the appropriation of

\$600,000 authorized by chapter 694 of the Acts of 1912 for the purchase of certain property from the City of Boston, and in view of the uncertainty regarding the cost of construction work at the present time and the possibility that the new main may be required for the East Boston service, the Board recommends that authority be given to use this balance for the construction of the 36-inch main for the East Boston service and for the increased cost of the works authorized under chapter 172 of the General Acts of the year 1916, due to the present increase in cost of labor and materials.

The original estimate for the construction of the Wellesley Extension, High-level sewer, of \$350,000 was made by the State Board of Health, and was based on a report submitted by an engineer called in by that Department to make a survey and estimate. Two lines were considered by the Board of Health. The estimate was made on the shorter line which came through the location of the Brookline Water Works fields. This line was to connect with the existing Neponset Valley Sewer of the High-level System at a point where the sewer has a capacity suitable only for the original district for which it was built.

Because of the small size of this existing Metropolitan sewer and the fact that this line extended across the Brookline Water Works fields and would interfere with this important supply, and also because of the fact that there is a rapidly growing portion of Dedham in the vicinity of Bridge Street which is a part of the Metropolitan District and has no possible means of reaching the Metropolitan System excepting by construction work by the Metropolitan Water and Sewerage Board, it was decided to use the alternate line proposed by the State Board of Health. This is somewhat longer but reaches the existing Metropolitan sewer at a point where the latter is of increased size and at the same time furnishes a means of outlet for the above-named portion of Dedham and obviates the difficulties in connection with our construction in the fields of the Brookline Water Works.

The Board also has designed a sewer of considerably larger capacity than was anticipated by the State Board of Health, feeling that the same is justified by the future demands of the District.

The line adopted has a length of about 40,000 feet almost wholly through private lands. It has been divided into sections numbered from 98 to 106, inclusive. At the present time sections 103, 104, 105 and 106 are wholly completed. Section 102 is under contract and about one-fourth completed. Section 98 is under construction with but a small amount of the work completed.

The natural physical conditions in this part of the Charles River valley make sewer construction very expensive. This is occasioned by the large amount of rock encountered and by fine sands and other material in which it is expensive to construct and by the remoteness of the location.

Because of the above-stated conditions, namely, insufficiency of the original appropriation, not based on estimates made by the Metropolitan Water and Sewerage Board, and the necessary changes in the location to fit the needs of the District, the bad material encountered and, above all, the abnormal conditions of the market in regard to labor and supplies, it is necessary that an additional appropriation be asked for to complete the work.

Following is the cost of the completed sections with an estimate of the cost of the remaining ones:—

Total Cost of Sections 98 to 106, inclusive (excluding Land Damages).

SECTION.	Cost.	Length (Feet).
106,	\$43,000	4,355
105,	44,000	4,425
104,	70,000 ¹	4,300
103,	45,000	5,916
102,	71,000 ²	6,851
101,	75,000 ²	3,950
100,	85,000 ²	3,700
99,	90,000 ²	3,300
98,	90,000 ²	3,350
	\$613,000	40,147
Administration,	10,000	
Total estimated cost,	\$623,000	

¹ Approximately.

² Estimated.

showing that the probable cost of construction work on this line will amount to \$623,000 including engineering and incidentals. To this must be added the cost of land damage and any settlements of outstanding claims by contractors. The Board, therefore, asks for an additional appropriation of \$325,000.

Since filing the annual estimates substantial increases in compensation to wage earners performing work of a similar character to that required of the workmen, laborers and mechanics in the employ of the Board have been granted. In view of these increases and the unusual conditions now prevailing, the Board believes that the wages of the employees in the water and sewerage pumping stations and others engaged in the care and maintenance of the water and sewerage works should be increased, and it respectfully recommends that additional appropriations be made providing for such increases.

If such increases are authorized the sums required, in addition to the amounts already appropriated for the year 1917, will be as follows:—

Metropolitan Water Works,	\$24,000
Metropolitan Sewerage Works, North System,	10,500
Metropolitan Sewerage Works, South System,	6,500

The detailed reports of the Chief Engineer of the Water Works and of the Chief Engineer of the Sewerage Works, with various tables and statistics, are herewith presented.

Respectfully submitted,

HENRY P. WALCOTT,
EDWARD A. McLAUGHLIN,
THOMAS E. DWYER,

Metropolitan Water and Sewerage Board.

Boston, February 23, 1917.

REPORT OF CHIEF ENGINEER OF WATER WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN: — I have the honor to submit the annual report of the work done under the direction of the Chief Engineer of Water Works in connection with the construction, maintenance and operation of the Metropolitan Water Works for the year ended December 31, 1916.

ORGANIZATION.

The organization of the force employed under the direction of the Chief Engineer remained the same as at the close of the previous year until November 1, 1916, when Mr. John L. Howard, who had formerly been employed in the department, from 1895 to 1903, was appointed as Assistant to the Chief Engineer. The principal assistants employed at the close of the year were as follows: —

John L. Howard, . . .	Assistant to the Chief Engineer.
Elliot R. B. Allardice, . . .	Superintendent of Wachusett Department.
Charles E. Haberstroh, . . .	Superintendent of Sudbury Department.
Samuel E. Killam, . . .	Superintendent of Distribution Pipe Lines and Reservoirs.
Arthur E. O'Neil, . . .	Superintendent of Distribution Pumping Stations.
Alfred O. Doane, . . .	Division Engineer, in charge of Mechanical Engineering and Inspection Work.
William W. Locke, . . .	Sanitary Inspector.
Clifford Foss, . . .	Assistant Engineer in charge of Construction Work.
Benjamin F. Hancox, . . .	Head Draftsman.
James W. Killam, . . .	Assistant Engineer in charge of Coal and Oil Testing and maintenance of Recording Pressure Gages.
William E. Whittaker, . . .	Office Assistant.
Charles E. Livermore, . . .	Biologist.

Including these principal assistants the number of supervising, engineering and clerical employees has averaged 45 during the year.

In addition to the above force the number of employees engaged in maintaining and operating the reservoirs, aqueducts, pipe lines, hydro-electric stations and pumping stations and doing minor construction work has been as follows:—

DEPARTMENT.	Beginning of Year.	End of Year.	Maximum.	Average.
Wachusett,	45	42	74	56
Sudbury,	58	57	77	61
Distribution, pipe lines and reservoirs, . .	80	78	97	85
Distribution, pumping stations,	55	56	58	56
	238	233	306	258

CONSTRUCTION.

COMPLETION OF 60-INCH WESTON AQUEDUCT SUPPLY MAIN.

At the beginning of the year the 60-inch Weston Aqueduct Supply Main, authorized under chapter 320 of the Acts of the year 1909, was nearly completed, only 144 feet of pipe line remaining to be laid in Commonwealth Avenue, in Newton. This work was completed on January 13, but the work of resurfacing the street over the pipe trench was carried on intermittently by the city of Newton until February, when it was suspended on account of bad weather. The work was resumed April 1 and completed in August.

The expenditures for this work during the year 1916 amount to \$26,354.15 and the total expenditures for the pipe line since the work was begun in 1909 amount to \$707,363.07.

IMPROVEMENT OF BEAVER DAM BROOK.

The plans and specifications for the improvement of Beaver Dam Brook, which is a tributary of Lake Cochituate located in the towns of Ashland, Framingham, Sherborn and Natick, were completed and proposals for the work were received from contractors on July 24. The appropriation for this work, which was authorized by chapter 814 of the Acts of the year 1913, is \$33,000, and as all of the proposals received exceeded the appropriation they were rejected.

ADDITIONAL 24-INCH MAIN FROM DORCHESTER LOWER MILLS TO QUINCY.

At the beginning of the year this main was completed with the exception of the box to protect from frost the 24-inch steel pipe which is suspended from the bridge over the Neponset River. During the year the box was framed at the carpenter shop at the Chestnut Hill pipe yard and given a coat of paint and during August and September was erected about the pipe. The cost of the work was \$464.17 which, with the miscellaneous payments on account of the pipe line during the year, makes a total of \$1,153.19.

BELLEVUE RESERVOIR.

At the beginning of the year the southern extra high-service reservoir on Bellevue Hill in West Roxbury had been completed, with the exception of laying the asphalt and tile on the roof and the granolithic floor between the steel tank and the masonry wall and of finishing the pipe connections and the grading around the tower.

The work on the masonry tower, under the contract with John Cashman & Sons Company, was continued during favorable weather until the roof was completed on March 18. The granolithic floor was laid, the painting completed and the stone masonry cleaned down with a sand blast during May and June and the entire work was completed on July 11.

The old steel tank and wooden tower constructed at this place by the city of Boston in 1886 was removed by the city after the new reservoir was completed. The pipe connections and the grading were completed by the department force during the latter part of the year.

The expenditures for this project during the year amounted to \$16,374.27, making the total cost of the reservoir \$87,769.18, which is subdivided as follows:—

Foundation,	\$11,096 04
Steel tank,	17,221 58
Tower,	46,659 14
Grading and miscellaneous,	1,545 82
Engineering,	11,246 60
	<hr/>
	\$87,769 18

SUDBURY POWER PLANT.

The work of constructing the hydro-electric plant at the Sudbury Dam in Southborough, which was begun in June, 1915, has been continued throughout the year 1916 and with the exception of a few unimportant details is now completed. A description of this plant was given in the previous annual report.

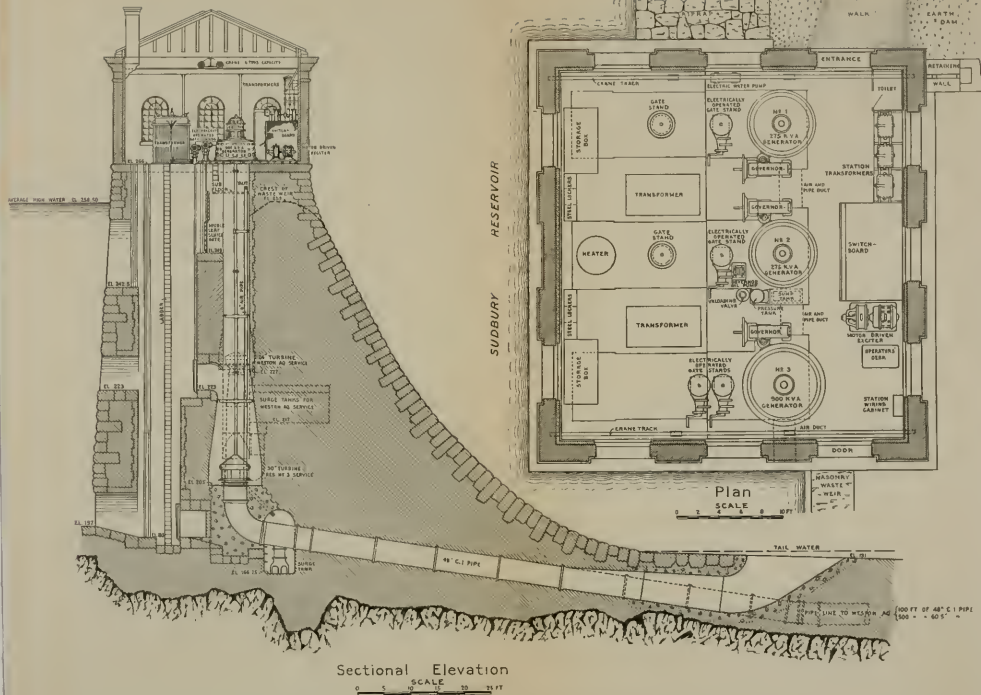
At the beginning of the year 1916 the hydraulic turbines and electric generators had been built and tested and the work of enlarging the wells of the existing gate-house for use as wheel pits and of constructing the surge tanks had been finished.

The three large double-leaf sluice gates, each 11 feet 2 inches high by 5 feet 6 inches wide, for controlling the flow of water from the reservoir to the turbines, were installed in February and the three electrically driven ball-bearing gate stands for operating the gates were installed in March. On account of the requirements of the hydro-electric service a similar gate stand was installed for operating the existing mid-depth sluice gate, which is 5 feet 3 inches high by 3 feet 3 inches wide and was formerly operated by hand. This gate is now used for controlling the flow through the low-level inlet to the 30-inch turbine. The double-leaf sluice gates and the gate stands were furnished and installed by the Coffin Valve Company of Neponset.

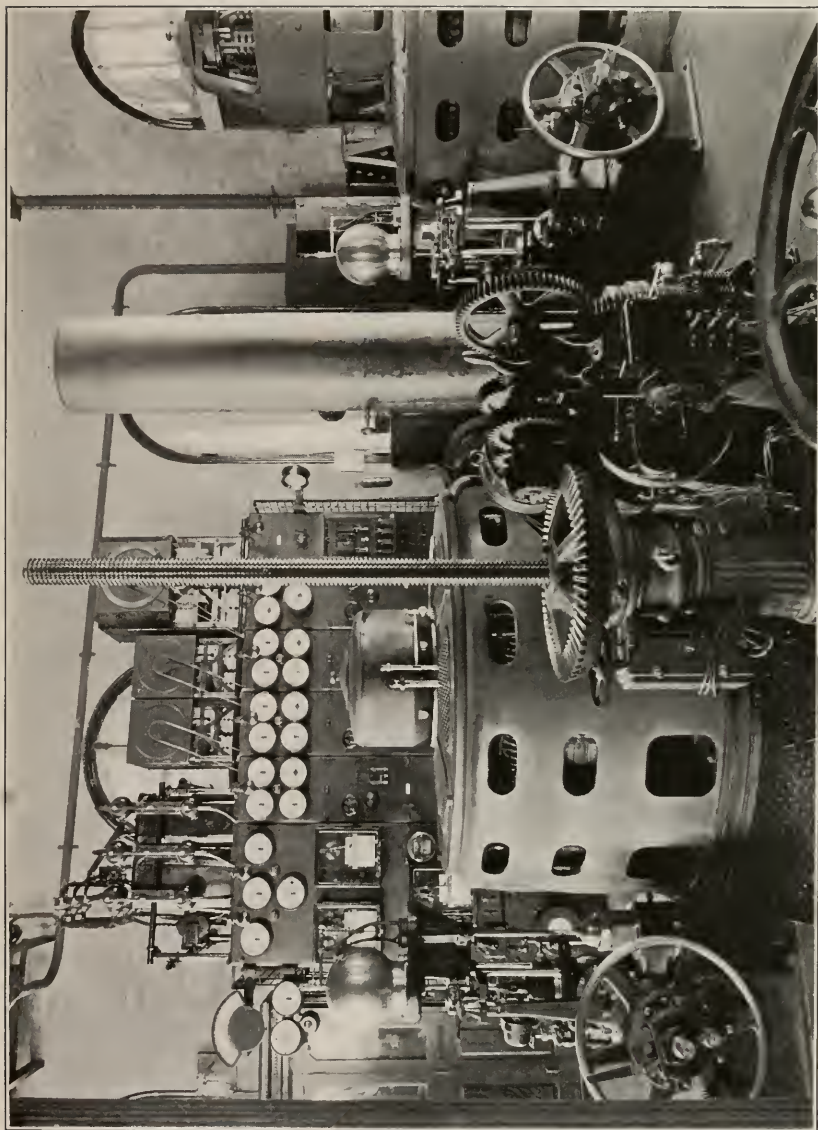
In February the Safety Insulated Wire & Cable Company furnished and installed about 1,550 linear feet of 3-conductor 15,000-volt underground cable in two lines between the power station and the lightning arrester chamber. These cables were successfully tested in place on May 24 and 26 under a pressure of 30,000 volts by the Testing Department of the Edison Electric Illuminating Company of Boston.

The lightning arrester chamber was built in an existing store house at the northerly end of the dam. It was formed by carrying up the exterior granite walls at the northwesterly corner of the store house and building concrete interior partition walls to form a fire-proof tower about seven feet square with a concrete roof. The overhead high-tension wires are brought in through Thomas roof insulators and the underground cables are brought up through the floor. A high wooden fence with barbed wire strung on outriggers

AVE
111



HYDRO - ELECTRIC PLANT - SUDBURY DAM



SODBURY POWER STATION — SHOWING SWITCHBOARD, GENERATORS, HYDRAULIC GOVERNORS AND ELECTRICALLY OPERATED GATE STAND.

at the top has been constructed around the chamber to safeguard the public.

The overhead transmission line was constructed by the department force and was completed during the latter part of April. It is 4,170 feet in length and extends easterly from the lightning arrester chamber to the connection with the Edison Electric Illuminating Company's line in Brewer Road at the Framingham-Southborough boundary line. It consists of three conductors of No. 2 stranded semi-hard drawn bare copper wire strung on 42 chestnut poles with Thomas 25,000-volt porcelain insulators, lee pins and galvanized steel cross-arms of the wishbone type, and a 7 strand galvanized steel ground wire $\frac{3}{8}$ of an inch in diameter is supported by bayonets on top of the poles and grounded at intervals of about 500 feet.

The S. Morgan Smith Company delivered the hydraulic machinery at the power station in the latter part of January and proceeded with its erection until early in March when the work had progressed as far as it was desirable to carry it without having the electric generators to connect with. On account of delay of the Westinghouse Electric & Manufacturing Company in delivering the electric equipment the generators were not received until May 6. Their erection was then begun and the installation of the hydraulic machinery was resumed on May 25.

During the latter part of June the S. Morgan Smith Company completed the installation of the two 24-inch and the 30-inch turbines which it furnished and of the three hydraulic governors furnished by the Commonwealth, and the Westinghouse Electric & Manufacturing Company completed the installation of the two 275 and one 900 kilo-volt-ampere capacity generators and began work on the switchboard.

On August 25 the machinery was started and operated without load. During the following week the electric apparatus was dried out and was put under full voltage on August 31. The units operate at a speed of 360 revolutions per minute and deliver 3-phase 60-cycle alternating current at a pressure of 2,400 volts, which is stepped up to 13,200 volts for transmission.

In attempting to repair a defect in one of the 750 kilo-volt-ampere transformers the cast-iron base was cracked and a new case was not received until late in November. The plant was put into regular

service, however, on September 14 and energy was delivered up to the capacity of the single transformer until the second transformer was put into service on November 27. Since that date all of the water drawn for supplying the District has been utilized for the development of electric energy, which has been sold to the Edison Electric Illuminating Company of Boston under a contract which provides for the purchase of all of the electric energy generated at this station for a period of five years from January 1, 1917.

The department force installed the electrolytic lightning arrester equipment furnished by the Westinghouse Electric & Manufacturing Company, also the ground plates for the arrester and for the electric equipment at the power station. This force also installed about 620 linear feet of iron conduit, which is embedded in the power station floor, for the station wiring, and put in the wires for the station lighting and for the power circuits for operating the sluice gates, governor oil pump and station water supply pump. An air inlet was constructed in the southerly wall of the station below the floor and fitted with a grating and damper so that the amount of air admitted to cool the generators may be regulated from the power station floor by means of a rod attached to the damper. Removable iron grating subfloors have been constructed in the wells under the generators for use in making inspections of the machinery and piping.

For the protection of the plant in case of fire the two large station transformers, which together contain about 2,080 gallons of oil, have been provided with quick opening oil drain valves connected by a line of 3-inch pipe to a large steel storage tank 14 feet 6 inches long and 5 feet in diameter coated on the interior with special oil-proof paint and buried in the ground outside of the station. In case of emergency the transformer oil drain valves can be instantly opened by operating levers near the switchboard which will allow the oil to flow quickly from the transformers into the storage tank. The drain piping is also arranged so that the oil in the transformer cases may be pumped through a filter press for purification when necessary.

The expenditures for the plant during the year amount to \$46,175.84 and the total expenditures to the close of the year amount to \$97,108.35. The cost of the plant, including reserves retained under contracts and other amounts not yet paid is \$100,881.52, subdivided as follows:—

Foundations, wheel pits and surge tanks,	\$46,906 14
Hydraulic turbines (1,600 horse power),	13,410 95
Hydraulic governors,	2,516 06
Electric equipment (1,450 kilo-volt-amperes),	20,859 76
Transmission line (1,550 feet underground, in 2 lines),	1,714 50
Transmission line (4,170 feet overhead),	1,914 54
Lightning arrester chamber,	1,175 17
Station floor, wiring, water supply, plumbing and furnishings,	1 291 71
Hand travelling crane,	880 00
Engineering and inspection,	10,212 69
	<hr/>
	\$100,881 52

WACHUSETT-SUDBURY TRANSMISSION LINE.

The preliminary work for the Wachusett-Sudbury transmission line was begun immediately after the acceptance, on September 25, of the joint proposal of the New England Power Company and the Edison Electric Illuminating Company of Boston for the purchase of all the electric energy to be generated at the Wachusett power station for a period of ten years from the completion of the proposed high-tension transmission line from the Wachusett power station in Clinton to the Sudbury power station in Southborough.

The transmission line will be about 16 miles in length and, with the exception of the steel towers required for several long spans which are necessary at certain points, the line will be suspended from chestnut poles about three-fourths of which will be cut from the standing timber on the water works lands surrounding the Wachusett Reservoir. A force of several men was engaged for three weeks in cutting and peeling the chestnut trees and 177 poles 40 to 50 feet in length were cut and taken out to the roadsides where they were skidded up ready for transportation to the points where they will be used. The cost of this work has averaged \$2.25 per pole.

The preliminary engineering and field work required in connection with the preparation of the plans and profiles of the transmission line has been completed. The total expenditures for the line amount to \$1,014.45.

ADDITIONAL NORTHERN EXTRA HIGH-SERVICE PIPE LINE AND PUMPING MACHINERY.

Under chapter 172 of the General Acts of the year 1916 provision was made for a 16-inch pipe line to extend from the northern extra

high-service standpipe in Arlington to the Lexington boundary line, a distance of about 6,000 feet. Provision was also made under this chapter for additions to the pumping machinery at the northern extra high-service pumping station in Arlington.

The present supply for Lexington is furnished from the Arlington standpipe through the local pipe lines belonging to the town of Arlington, which are used jointly by the Metropolitan Water Works and the town. In times of maximum consumption this service is not entirely satisfactory and the proposed 16-inch supply main is to be constructed to remedy this condition.

The preliminary plans for the proposed pipe line were prepared early in the summer and proposals were received for the cast-iron pipes and special castings required, but none was accepted because of the high prices. The contract plans for the pipe line have been completed but as the work is not extremely urgent it has been deferred until it can be done under more economical conditions.

The proposed improvements at the northern extra high-service pumping station include the installation of a steam driven centrifugal pumping unit with a capacity of 3,000,000 gallons in 24 hours, a return tubular boiler 54 inches in diameter x 17 feet in length, similar to the two boilers now in use, and the enlargement of the coal pocket. The plans and specifications for this work were nearly completed at the close of the year.

The total expenditures for the improvements in the northern extra high-service works during the year amount to \$202.86.

SOUTHERN EXTRA HIGH-SERVICE PIPE LINE.

Chapter 172 of the General Acts of the year 1916 also provides for the construction of a 12-inch southern extra high-service pipe line approximately 2,050 feet in length in Poplar Street, West Roxbury, and a duplicate 12-inch submerged pipe line about 360 feet in length for the Neponset River crossing at West Street in Hyde Park.

Preliminary plans have been prepared for these pipe lines which are to be constructed to provide more reliable service for the southern extra high-service districts in Hyde Park and Milton, but on account of the high price of cast-iron pipes and specials this work has also been deferred until it can be done under more favorable conditions.

The total expenditures for this work amount to \$136.59.

METERS AND CONNECTIONS.

As a result of the purchase in August, 1913, of the Boston Water Works supply mains located in Brookline and Somerville it has become necessary to relocate several of the Venturi meters and make some new connections in order to operate these pipe lines and measure the water supplied in a satisfactory manner. During the year contracts have been made for the Venturi meters, gate valves, check valves, special castings and other materials required for this work, but on account of delays in the delivery of some of the materials only a portion of the construction work has been completed.

In October a 36-inch connection, including a 36-inch main valve and 6-inch by-pass valve, was made between the former 48-inch Boston Water Works main and the easterly 48-inch Metropolitan Water Works Spot Pond line in Beacon Street at Winchester Street, Brookline, which will permit the use of the Spot Pond line for the Boston service. The cost of this connection was \$2,091.85.

Early in December a 20-inch Venturi meter with 6½-inch throat section, 6-inch blow-off and 20-inch check valve were installed on the former 20-inch Boston Water Works main in Harvard Street at the Boston-Brookline boundary line. On account of unfavorable weather the connection of the blow-off pipe with the drain was deferred and will be completed next season. The cost of the work at this place was \$988.53.

The 30-inch Venturi meter formerly maintained at the junction of Pearl and Walnut streets in Somerville was removed early in August, before the city of Somerville constructed the new street pavement at this place. A new 10-inch throat section was substituted for the old 13½-inch throat section formerly used with this meter and during December the meter was installed in the former Boston Water Works 30-inch cement and iron main on Perkins Street at the Boston-Somerville boundary line. A 30-inch check valve and 12-inch blow-off were also installed at this place but on account of the unfavorable weather the work of connecting the blow-off pipe with the sewer was deferred and will be completed next season. The cost of removing the meter and making the new installation was \$2,155.29.

ENGINEERING.

The engineering force employed in connection with construction work has made surveys, plans and studies for the various projects and prepared the contract specifications and estimates, and has supervised and inspected the work done and the materials furnished by the contractors.

MAINTENANCE.

RAINFALL AND YIELD OF WATERSHEDS.

The precipitation on the watersheds was below the normal until March 1; for the following three months it was close to the average; from June 1 to October 1 it was somewhat above the normal and was below the average during the remainder of the year.

The total precipitation for the year was 43.43 inches on the Wachusett watershed, 39.96 inches on the Sudbury watershed and 38.15 inches on the Cochituate watershed.

The average precipitation on the Wachusett watershed for the past twenty years is 45.30 inches; on the Sudbury watershed for the past forty-two years 44.67 inches, and on the Cochituate watershed for the past fifty-four years 45.30 inches.

The yield of the Wachusett watershed was above the normal during January and February, and April, May, June and July. The average for the year was 1,215,000 gallons per day per square mile, which is 13 per cent. greater than the average yield for the past twenty years. The yield of the Sudbury watershed was 904,000 gallons per day per square mile during 1916, which is 92 per cent. of the average during the past forty-two years and 1 per cent. greater than the average for the past nineteen years, the period during which water has been discharged into Sudbury Reservoir from the Wachusett watershed. The yield of the Cochituate watershed was 1,026,000 gallons per day per square mile in 1916, or 11 per cent. greater than the average for the past fifty-four years.

During the year the city of Worcester turned 4,397,000,000 gallons of water into the Wachusett watershed from the 9.35 square miles formerly in the watershed which it took for its water supply in 1911. Of this quantity 648,200,000 gallons were received between June 15 and December 15.

QUANTITY OF WATER STORED IN THE WACHUSETT RESERVOIR AND IN ALL THE STORAGE RESERVOIRS COMBINED DURING 1916



STORAGE RESERVOIRS.

The capacities of the storage reservoirs of the Metropolitan Water Works, the elevation of the water surfaces and the quantity of water stored in each reservoir at the beginning and at the end of the year are shown by the following table.

STORAGE RESERVOIRS.	Elevation ¹ of High Water.	Capacity (Gallons).	JAN. 1, 1916.		JAN. 1, 1917.	
			Elevation ¹ of Water Surface.	Amount stored (Gallons).	Elevation ¹ of Water Surface.	Amount stored (Gallons).
Cochituate watershed:—						
Lake Cochituate, ² . . .	144.36	2,097,100,000	142.93	1,760,000,000	143.23	1,830,100,000
Sudbury watershed:—						
Sudbury Reservoir, . . .	260.00	7,253,500,000	249.53	3,340,300,000	258.49	6,623,800,000
Framingham Reservoir No. 1.	169.75	287,500,000	167.89	224,300,000	167.70	216,100,000
Framingham Reservoir No. 2.	177.87	529,900,000	176.19	489,900,000	176.02	482,600,000
Framingham Reservoir No. 3.	186.74	1,180,000,000	184.48	1,017,600,000	183.53	942,300,000
Ashland Reservoir, . . .	225.21	1,416,400,000	224.53	1,379,000,000	224.28	1,365,200,000
Hopkinton Reservoir, . .	305.00	1,520,900,000	304.24	1,473,300,000	304.07	1,462,700,000
Whitehall Reservoir, . .	337.91	1,256,900,000	337.29	1,136,200,000	336.65	1,013,300,000
Farm Pond,	159.25	167,500,000	157.87	94,400,000	157.39	69,600,000
Wachusett watershed:—						
Wachusett Reservoir, . .	395.00	64,968,000,000	391.05	59,728,600,000	387.11	54,679,600,000
Totals,	—	80,677,700,000	—	70,643,600,000	—	68,685,300,000

¹ Elevation in feet above Boston City Base.

² To top of Flashboards.

² Excluding Dudley Pond which was abandoned April 3, 1916.

The diagram, facing page 56, shows the quantity of water stored in the Wachusett Reservoir and the quantity stored in all the storage reservoirs combined during the year.

Wachusett Reservoir.—At the beginning of the year the Wachusett Reservoir contained 59,728,600,000 gallons of water or 5,049,000,000 gallons more than at the close of the year. The water in the reservoir was 3.95 feet below high-water line or at elevation 391.05 at the beginning of the year. It rose gradually to elevation 392.96, which was reached on February 4, and remained at about this elevation until February 26. Between February 23 and 26 there was a precipitation of 2.78 inches of warm rain which caused the water to rise 1.8 feet in the reservoir by March 1, when it was at elevation

394.6, or within one-half a foot of high-water line. Water was then allowed to waste from the reservoir into the Nashua River below the dam in order to provide for the large yield which was anticipated from the deep accumulation of snow on the watershed. On March 15, the new sluice gates at the Sudbury power station having been set in position and tested, the filling of that reservoir, which had been drawn down for this work, was begun with water from the Wachusett Reservoir and the waste from the reservoir was stopped. Under the draft for filling the Sudbury Reservoir the elevation of the water in the Wachusett Reservoir subsided until March 25 when it was at elevation 392.16. It then rose steadily with the melting of the snow on the watershed until it reached high-water line on April 13, and remained above this elevation for the next four months, during which time water was wasted almost continuously, the waste having been resumed again on April 1 on account of the rapid melting of the snow which produced such a large yield that on April 2 it was necessary to waste water from the reservoir at the rate of 530,000,000 gallons per day, in addition to the draft of 250,000,000 gallons per day which was being maintained at the time for filling the Sudbury Reservoir.

From February 29 to August 1 19,378,500,000 gallons of water were wasted from the reservoir through the pipes into the pool below the dam or over the spillway into the waste channel. The maximum rate at which water was wasted from the reservoir was 680,000,000 gallons per day on June 3 and 4. The highest elevation reached by the water in the reservoir was 395.75 on June 11, and the lowest elevation was 387.07 on December 30. No water was wasted from the reservoir after August 1 and the water surface, which was at elevation 395.48 at that time, subsided with the constant draft for water supply at a practically uniform rate until the end of the year when it was at elevation 387.11.

There has been discharged from the reservoir through the pool below the dam and the pipe line leading to the canal at the Lancaster Mills 1,018,100,000 gallons of water, in accordance with the provisions of section 4 of chapter 488 of the Acts of the year 1895, which requires that not less than 12,000,000 gallons and such further quantity, not exceeding 12,000,000 gallons, as the owners of the mills shall deem necessary, shall be allowed to flow from the reservoir during each week.

The emergency pumping station of the city of Worcester, located on the shore of the reservoir at South Bay in Boylston, was not operated by the city during the year.

To prevent organic matter from being washed into the reservoir by the action of the waves on the slopes near Pine Hill in West Boylston the soil was stripped from an area 670 feet in length and from 5 to 60 feet in width, containing 0.2 of an acre, at a cost of \$243.22.

Miscellaneous débris brought into the reservoir during high water flow in the spring was collected from the shores and disposed of at a cost of \$202.84.

Brush and weeds have been mowed, raked up and burned along the sides of the highways adjoining the water works lands and the brooks flowing directly into the reservoir; along the margin of the reservoir for a distance of about 2 miles; from a strip of water works land about 100 feet in width extending for a distance of $2\frac{1}{2}$ miles along the highways bordering the reservoir, and at the North and South dikes. This work extended over a distance of $29\frac{3}{4}$ miles and cost \$1,638.45.

The bed of the Stillwater River for a length of about 650 feet above the Stillwater basin, where large quantities of material had been washed into it during freshets, was straightened and deepened about 1 foot for an average width of 50 feet at a cost of \$377.28.

The brook which enters the reservoir at Hastings Cove in Boylston was straightened, graded and paved on the bottom and sides for a length of 972 feet at a cost of \$713.30.

A steam heating plant was installed at the Tucker house in Boylston, which is occupied by patrolman Knight, who furnished the heater. The radiators and piping were furnished from the department storage yard and the labor was performed by the department employees.

The buildings at the Clinton and Oakdale storage yards have been kept in good condition. The dwelling purchased from Rosie A. Howe last year, located near Waushacum Brook at Sterling Junction, has been rented to one of the department employees since November 1.

A ditch 587 feet in length and about $2\frac{1}{2}$ feet in depth was excavated, and concrete head wall and two 15-inch vitrified pipe culverts were constructed to provide an overflow at times of high water from the Lily Ponds at West Boylston. The excavated material was

used for subgrading the forest road at this place, which was later surfaced with gravel. The cost of the work was \$183.90.

Wheelock wire fences were constructed along the boundary of the water works land for a distance of 2,767 feet at the Andrew J. Scarlett and W. A. Woods lands in West Boylston and the William Kingsbury land in Sterling at a cost of about 10 cents per linear foot. An equivalent length of party fence was constructed by these adjoining owners.

The plank foot-bridge over the waste-weir at the dam, where unsafe, and two cracked cast-iron standards were repaired at a cost of \$160.77.

Sudbury Reservoir. — At the beginning of the year the water in Sudbury Reservoir was at elevation 249.53 or 9.47 feet below the crest of the waste-weir, having been kept down in connection with the construction of the power plant, and, with the exception of a few days early in February, the water was kept below this elevation until March 15 when it was at elevation 246.58. After this date there was no further necessity for keeping the water at a low elevation and during the following three weeks the reservoir filled to the crest of the waste-weir, largely with water let down from the Wachusett Reservoir for this purpose. From April 11 to 26 water was allowed to flow over the waste-weir, which is at elevation 259. The flashboards were then put in place and the reservoir filled to high-water line, or elevation 260.

From April 26 to September 28, when the hydro-electric unit for the Framingham Reservoir No. 3 service was put into regular operation, the supply for Reservoir No. 3 was drawn over the waste-weir by regulating the flash-boards. After September 28 the water in the reservoir was kept below the top of the flash-boards and the entire supply to Reservoir No. 3 was passed through the turbine and used for the generation of electric energy. The flash-boards were removed on November 28, when the ice began to form, and the water was thereafter maintained from half a foot to a foot below the crest of the waste-weir.

The usual attention has been given to the care of the reservoir lands and structures. Objectionable material which had collected in the coves was removed; the brush was mowed in the lanes through the woods along the boundary lines for a distance of 8 miles; the stone wall in Clemmons Street was repaired; 17 chestnut poles were

cut for future use in constructing a permanent telephone line to replace the temporary line now maintained over private land; the life preservers and holders and the iron flash-board standards for the waste-weir were painted and 15 new stop-planks were made for use in the power station.

The lower tenement in the house near the dam was painted and papered at a cost of \$111.96, and has been occupied by the operator in charge of the power station since August 26, 1916. Leaks in the pipe through which water is supplied to the house and barn were repaired. Some repairs were made at the Cratty house in Fayville.

The leaks in the copper roof of the power station were repaired at a cost of \$140.56 and the walks and drives and grass land disturbed by the construction of the power plant were repaired.

The runabout auto-truck purchased last year for the use of the foreman in charge of the work at the reservoir has materially increased the efficiency of the labor force and been of much value in extinguishing fires. The distance covered with the auto-truck during the year was about 7,200 miles.

A parcel of land containing an area of one acre, located near the junction of Marlborough and Sears roads in Southborough, was acquired in fee during the year.

Framingham Reservoir No. 3. — All of the water delivered through the Sudbury Aqueduct for the supply of the Metropolitan Water District was drawn from this reservoir which was in turn supplied with water from the Sudbury Reservoir as required, and on account of using the reservoir in this manner the flash-boards were kept on the overflow throughout the year and the water in the reservoir fluctuated between elevation 183 and 186 during the greater part of the year. In the latter part of March and early part of April the water was drawn down to elevation 181.50, and at times in April, May and June water was wasted over the top of the flash-boards which were at elevation 186.50. Water was also wasted from the reservoir through the waste gates at times from February to June, inclusive, and in November and December.

The gate-house and dam received the usual care. Fertilizer was spread over the embankment and the boat house was shingled and painted. Brush was mowed and burned in the lanes through the woods along the boundary of the reservoir lands for a distance of 2.5 miles.

Framingham Reservoirs Nos. 1 and 2, Ashland, Hopkinton and Whitehall Reservoirs. — No water was drawn from these reservoirs for the supply of the District during the year and they were kept substantially full, and, with the exception of Whitehall Reservoir, with the flash-boards on the overflows except during cold weather when they were removed on account of the ice. The water was drawn down a foot or so, as usual, during the freshet season so that the amount of water wasted down the Sudbury River could be conveniently regulated.

A discharge of not less than 1,500,000 gallons per day was maintained throughout the year from Reservoir No. 1 into the Sudbury River, as required by the provisions of chapter 177 of the Acts of the year 1872, and water was also discharged in larger quantities from time to time as required to dispose of a portion of the yield of the watershed above Dam No. 1 which could not be stored in the reservoirs.

The usual attention was given to the dams, gate-houses and structures at these reservoirs. Fertilizer was spread on the embankments at Reservoirs Nos. 1 and 2. The riprap slopes and the grounds at all dams and the ironwork and stop-planks at the gate-houses have been kept in good condition. The foreman's house and barn and the tool-house at Reservoir No. 1 were painted and minor repairs were made at the premises occupied by the attendants at the Ashland and Hopkinton reservoirs, and some pointing was done at the waste-weir at the Ashland Reservoir. Brush has been mowed and burned for a total length of 19 miles along the waste channels and in the lanes through the woods along the boundary lines of the water works lands at these reservoirs, and 6,200 linear feet of new lanes have been cut at Hopkinton Reservoir.

At Whitehall Reservoir some grading was done on the water works lands located along the outlet brook between Wood Street and the lower mill pond dam and at the upper end of the brook near the reservoir. The number of cottages located on the shore of the reservoir is 65, which is the same number as at the close of last year. There were 11 motor boats, 80 row boats and 34 canoes in use on the reservoir during the year or a total of 125, which is an increase of 2 since last year.

The foreman who has charge of the work at these reservoirs is also in charge of the work at Reservoir No. 3 and Cedar Swamp,

and on account of the large area covered and the satisfactory results obtained during the previous year with the runabout truck at Sudbury Reservoir a similar truck was purchased for his use in April and at the close of the year he had traveled a distance of 6,900 miles in the truck in connection with his work.

Farm Pond. — The water in Farm Pond was 1.38 feet below high water line at the beginning of the year. It rose gradually until May 1 when it was 0.41 of a foot below high-water line. It then fell slowly and was 1.86 feet below high water at the close of the year.

Under the rights reserved by legislation the town of Framingham and the railroad companies have continued to take water from the Farm Pond drainage area for water supply during the year, but no water was discharged into the pond from sources outside its watershed. No water was wasted from the pond and no water was drawn from it for use in the Metropolitan District.

During the year the town of Framingham pumped 230,300,000 gallons for a portion of its water supply from the filter-gallery located on the easterly shore of the pond, and the Boston & Albany and New York, New Haven & Hartford railroad companies took approximately 145,000,000 gallons directly from the pond.

Lake Cochituate. — At the beginning of the year the water in Lake Cochituate was at elevation 142.93 or 1.43 feet below high-water line, and water was wasted from the lake as required to dispose of the yield between January 1 and July 26 and have the water down about 2.8 feet to allow for anticipated work on the improvement of Beaver Dam Brook, which, however, was not carried out, and the water in the lake was allowed to rise gradually and had reached elevation 143.23 at the end of the year. No water was discharged into the lake from outside its watershed during the year.

New tin was put over the entire roof of the effluent gate-house, to replace the former tin roof which had been in service many years and was blown off by a heavy wind during a storm in December, 1915.

At the shop the 5 horse power engine and boiler were removed and a 9 horse power Hoadley engine from the store-house at Framingham was installed in place thereof, and a lean-to about 16 feet long x 8 feet wide was constructed for housing the auto truck.

The automobile used by the superintendent and sanitary inspectors, the truck used along the aqueduct lines and the motor

boat used on the lake were overhauled and repaired by the force at Lake Cochituate.

In connection with the maintenance of the surface water drain from Cochituate Village the grass was mowed on the slopes of the open channel and the sediment was removed from the catch basins and from the sand catcher on Bannister's Brook.

Minor repairs were made at the barn, wagon shed and foreman's house and some painting and papering were done at the house. During the year 16 cottages and 2 garages were built by the adjoining property owners, making a total of 90 cottages around the lake at the end of the year.

Alonzo S. Carson, who was employed as foreman at the lake by the city of Boston from June 14, 1889 to January 1, 1898, and after that date by this department, died on March 21 and since then John Ralston has had charge of the work at the lake in addition to the work along the Cochituate, Sudbury and Weston aqueducts.

Dudley Pond. — Under the provisions of chapter 94 of the General Acts of the year 1916, which took effect April 3, the connection with Lake Cochituate was permanently closed and all interest in and control over the waters of the pond were transferred to the town of Wayland on April 18.

AQUEDUCTS.

Wachusett Aqueduct. — Water was discharged through the Wachusett Aqueduct from the Wachusett Reservoir during 321 days in 1916. The total time that the aqueduct was in use is equivalent to 174 days, 10 hours and 41 minutes, and the total quantity of water discharged was 37,448,200,000 gallons, equivalent to an average of 102,317,000 gallons per day for the entire year. This quantity does not include 3,700,000 gallons used in cleaning the aqueduct.

The Westborough State Hospital pumped 62,972,000 gallons of water, equivalent to an average consumption of 172,000 gallons per day, from the open channel at the lower end of the aqueduct.

The usual care has been taken of the aqueduct lands and structures and the brush, grass and weeds have been cut. The mowing covered a length of 10 miles and cost about \$87 per mile. Wheelock No. 65 wire fence was constructed along the aqueduct land for a length of 13,383 feet, at a cost of 15 cents per linear foot including 16 iron gates each 10 feet in length. This fence replaces a spruce board fence which was erected in 1897. About $6\frac{1}{4}$ acres of aqueduct

embankment in Berlin and Northborough were regraded, dressed with fertilizer and sown with grass seed at a cost of \$77 per acre.

The work of improving the 6-acre parcel on the north side of the open channel, just below the upper dam, which was begun in 1915 has been continued, the work this year including the construction of 480 feet of board bottom drainage ditch and grading and seeding. The ditch cost \$1.05 per linear foot and the grading and seeding cost \$19 per acre.

The upper 7 miles of the aqueduct was thoroughly scrubbed on the inside with stiff brooms and clean water in August, at a cost of \$43 per mile. This work included the application of a wash of two coats of Portland cement grout containing 2 per cent. Medusa waterproofing compound to a length of 25 feet of the aqueduct at the westerly end of the Assabet Bridge, in continuation of the work done last year, to check a slight leakage which continued at this place.

Early in the summer the portion of the open channel from the terminal chamber of the masonry aqueduct down to the upper dam was improved along the shore line by removing bunch grass and other vegetation and regrading the slopes with the fine material washed down by the flowing water and facing them with heavy gravel found along the shores. The cost of the work was 3.2 cents per linear foot of shore line, which is equivalent to a maintenance cost of less than \$11 per mile of shore line per year. This work completed the improvement of the shore line of the open channel for its entire length, which has been in progress during the past two years.

A parcel of land containing 3.33 acres, located near the terminal chamber of the Wachusett Aqueduct, between the open channel and the New York, New Haven and Hartford Railroad, was acquired in fee, and an easement in a strip of land containing 0.33 of an acre, extending from the railroad to Cedar Street, was acquired for a right of way to the terminal chamber.

Sudbury Aqueduct. — With the exception of 5 hours, on July 11, the Sudbury Aqueduct was in service throughout the year for conveying water from Framingham Reservoir No. 3 to the Chestnut Hill distributing reservoir. The total quantity of water discharged through the aqueduct was 18,431,700,000 gallons, equivalent to an average of 50,360,000 gallons per day for the entire year, which is 12,901,000 gallons per day less than in 1915. This reduction was

due to the increased flow in the Weston Aqueduct since February 8, when the new 60-inch Weston Aqueduct Supply Main was put in service.

The interior of the gate-house at Farm Pond was cleaned and painted and minor repairs were made to other structures along the line of the aqueduct. The culverts were kept free from snow and ice; brush, grass and weeds were mowed where the aqueduct land is not cared for by the adjoining owners. Chemical fertilizer was spread over the embankments where necessary to keep the land in good condition, 28,500 pounds of fertilizer being used for this purpose.

The town of Wellesley laid a 6-inch water pipe in Brookside Road over the two 48-inch pipes and under the 60-inch pipe at the Rosemary siphon. The city of Newton constructed 620 feet of 8-inch sewer and 1,080 feet of 6-inch water pipe parallel with the aqueduct in Tyler Terrace. For the sewers cast iron pipe with lead joints was used and the laying of the pipe was carefully inspected to make sure that it was perfectly tight.

Weston Aqueduct. — Water was supplied from the Sudbury Reservoir to the Weston Reservoir through the Weston Aqueduct on 353 days during the year. The total time that this portion of the aqueduct was in service was equivalent to 327 days, 4 hours and 50 minutes, and the total quantity of water discharged was 19,288,000,000 gallons, equivalent to an average of 52,699,000 gallons per day for the entire year, which is 19,126,000 gallons per day more than in 1915, due to the increased flow since February 8, when the new 60-inch Weston Aqueduct Supply Main was put into service. This portion of the aqueduct was out of service twice in January and twice in February in connection with the installation of the hydro-electric machinery in the Sudbury power station, and the entire aqueduct was out of service from April 26 to May 1, inclusive, while the Weston Aqueduct Supply Mains were shut off. Since the installation of the hydro-electric machinery at the Sudbury power station was completed, on November 26, the upper portion of the Weston Aqueduct has not been in service on Sundays and holidays and the total flow for the week has been discharged between 7 A.M. and 11 P.M. on the other days.

At the head-house, near the Sudbury Dam, several joint leaks were repaired in two of the 60-inch pipe lines. These pipes enter

the head-house on the up-stream side. The leaks were detected from the water which rose to the surface of the ground. The pipes were uncovered and small joint leaks were found, one on top of pipe line No. 2 at the 6th joint from the end of the pipe line in the head-house, one on top of pipe line No. 3 at the 5th joint, and another extending over the upper half of the 4th joint in this line. The weir and wooden racks formerly maintained in the head-house were removed and all necessary changes were made to provide for the use of the aqueduct in connection with the operation of the Sudbury power station. The iron columns which support the floor of the head-house, the floor beams at siphon chamber No. 1 and all of the manhole covers along the line were painted.

The lower aqueduct lands and terminal chamber were cared for by the usual force.

All of the culverts have been kept free from snow and ice. At the White place in Nobscot some painting and papering were done and the roof of the shed of the store-house was shingled.

Several stretches of fence were repaired, the brush, grass and weeds were mowed on the aqueduct land and chemical fertilizer was spread over the embankments where necessary to maintain them in fertile condition. About 22,000 pounds of fertilizer was used and approximately two-thirds of the total area of the embankments was fertilized. This work was located principally between Edgell Street, Framingham, and Main Street in Wayland. The sprouts in the lanes through the woods along the boundary lines of the aqueduct lands at the White place were cut and burned.

Cochituate Aqueduct.—No water was discharged through the Cochituate Aqueduct during the year and only the portion of it below the influent chamber at Chestnut Hill Reservoir was used in connection with the operation of the works.

The embankments along the line were dressed with chemical fertilizer where necessary to keep them in satisfactory condition; 6,000 pounds of fertilizer was used for this purpose. The culverts along the line have been kept open, new fences have been built for a length of 555 feet and the old fence on the north side of Washington Street in Wellesley was removed. Brush, grass and weeds were mowed along the line.

Considerable work has been done in the vicinity of the aqueduct

during the year by the town of Wellesley in constructing its new sewerage system. In connection with this work a 12-inch sewer was laid under the aqueduct just east of Morton's culvert, which is located a short distance from the Town Hall. The aqueduct at this place is built in quite a high embankment and to guard against possible injury to the aqueduct from settlement, the contractor who was laying the sewer for the town was not allowed to carry the trench excavation into the slopes of the embankment beyond the point where the material supporting the aqueduct would stand at the angle of repose, and he was required to securely sheet and brace the excavation. A pipe 24 inches in diameter and 20 feet in length, made of steel plates $\frac{3}{8}$ of an inch in thickness, was then forced under the aqueduct by using a 35-ton hydraulic jack and excavating the material from the end of the pipe as it was pushed ahead. To keep the pipe on line and grade the portion projecting beyond the embankment was securely held in a timber cradle constructed for the purpose. The time required to force the pipe under the aqueduct was six days, the daily progress varying from $1\frac{1}{2}$ feet to $4\frac{1}{2}$ feet. The material excavated was fine sand for the lower two-thirds, with gravel filling for the upper one-third. After the 24-inch pipe was forced through a 12-inch cast-iron sewer pipe was laid inside of it and the space between the pipes was filled solid with cement grout under pressure.

Sewers 8 inches in diameter were constructed across and over the aqueduct at Rice Street, Forest Street and Laurel Avenue. Sewers 10 inches in diameter were laid above the aqueduct in Central Street between Weston Road and Linden Street for a distance of 1,327 feet, and although the structures are approximately parallel the sewer crosses the aqueduct three times. A sewer 10 inches in diameter was also constructed above the aqueduct for a distance of 680 feet in Washington Street. This sewer crosses the aqueduct at Abbott Road and runs northeasterly parallel to and about 25 feet east of the aqueduct.

All of the sewers located near the aqueduct were laid with cast-iron pipes and lead joints and the manholes were thoroughly plastered with Portland cement mortar under our inspection to insure watertight work.

SANITARY INSPECTION OF WATERSHEDS.

The usual sanitary inspection of the watersheds was made during the year for the purpose of preventing pollution of the water supply. A summary of the work is given in the tables on pages 70 and 71.

Ice cutting operations were inspected at several ponds and reservoirs during the winter and special watchmen were employed from May to September, inclusive, to prevent bathing and unauthorized boating or fishing in the reservoirs.

Wachusett Watershed.

On the Wachusett watershed 2 dwellings were built during the year in Boylston, 14 in West Boylston and 7 in Holden; and 12 premises were destroyed by fire and 2 removed. Five small cottages were built at the Waushacum Lakes in Sterling. As a result of these changes there has been an increase of 14 premises on the watershed during the year, making a total of 1,720 premises.

Summary of Sanitary Inspections on the Wachusett Watershed in 1916.

DISTRICT.	Number of Premises In- spected. ¹	CLASSIFICATION OF CASES INSPECTED.												CONDITION AT END OF YEAR.		WATER SUPPLY.			
		Cesspools dug before 1916.	Cesspools dug during 1916.	Direct Privy Drain- age.	Indirect Privy Drain- age.	Direct Sink Drainage.	INDIRECT SINK DRAINAGE.		BATH DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.	Premises having Pub- lic Supply.	Premises having Pri- vate Supply.	Premises on which No Water is used.
							Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.									
French Brook, . . .	70	41	2	-	-	-	20	-	21	-	-	7	2	-	70	-	8	58	4
Muddy Brook, . . .	41	16	-	-	-	-	20	-	21	-	-	2	1	1	41	-	-	39	2
Gates Brook, . . .	209	142	9	-	-	-	43	1	51	1	-	10	2	-	208	1	3	194	12
Malden Brook, . . .	34	16	-	-	-	-	17	-	20	-	-	2	1	-	34	-	-	33	1
Chaffin Brook, . . .	210	122	6	-	-	-	65	6	89	-	1	7	2	-	203	7	88	115	7
Asnebumskit Brook, . .	218	163	3	2	10	2	24	2	45	2	3	12	4	1	201	17	190	22	6
Muschopauge, . . .	92	42	-	-	-	-	39	2	41	1	1	9	1	-	89	3	8	79	5
South Wachusett Brook, Trout Brook, . . .	87	40	-	-	-	-	37	-	41	1	-	8	3	-	86	1	-	83	4
East Wachusett Brook, .	34	5	-	-	-	-	22	-	22	-	1	4	-	-	33	1	-	32	2
Stillwater River, . . .	214	94	4	-	1	3	89	3	95	1	-	21	4	1	209	5	-	205	9
Wachusett, . . .	143	66	1	-	-	-	54	2	64	3	-	12	1	1	139	4	-	133	10
French Hill, . . .	334 ²	82 ³	- ³	-	-	-	76 ³	2	59	1	-	5	7	94	331	3	-	323	11
Totals, . . .	34	28	1	-	-	-	4	-	13	-	-	2	-	-	34	-	-	33	1
	1,720	847 ³	26 ¹	0	2	11	510 ³	18	582	10	6	101	28	98	1,678	42	297	1,349	74

¹ On some premises there are two or more cases.² Including 160 summer dwellings at the Wachusett Lakes.³ Summer dwellings not classified.

Summary of Sanitary Inspections on the Sudbury and Cochrute Watersheds in 1916.

DISTRICT.	Number of Premises Inspected. ¹	CLASSIFICATION OF CASES INSPECTED.														CONDITION AT END OF YEAR.		
		Sewer Connections.	Cesspools dug before 1916.	Cesspools dug during 1916.	Direct Privy Drainage.	Indirect Privy Drainage.	Direct Privy Drainage.	INDIRECT SINK DRAINAGE.		BARN DRAINAGE.		Manufacturing Wastes.	Premises Vacant.	No Drainage.	Drainage carried to Filter-beds.	Satisfactory.	Unsatisfactory.	
								Satisfactory.	Unsatisfactory.	Satisfactory.	Unsatisfactory.							
SUDBURY WATERSHED.																		
Farm Pond,	326	312	6	—	—	—	—	—	—	—	12	—	—	4	6	—	326	—
Framingham Reservoir No. 3,	98	—	64	—	—	—	—	24	2	44	1	—	—	4	4	—	95	3
Stony Brook,	300	—	259	—	—	—	—	23	2	33	4	—	—	6	6	2	294	6
Angie Brook,	2,028	1,637	267	5	—	—	—	85	2	196	1	—	—	21	17	1,829	2,026	2
Framingham Reservoirs Nos. 1 and 2,	333	—	250	3	—	—	—	60	1	98	1	—	—	19	1	—	332	1
and Cold Spring Brook,	230	—	200	11	—	—	—	9	—	26	—	—	—	3	5	—	230	—
Eastern Sudbury,	404	—	237	—	—	—	—	103	6	63	3	—	—	41	7	—	395	9
Indian Brook,	183	—	109	1	—	—	—	47	7	53	2	1	—	10	9	—	175	8
Western Sudbury,	177	—	63	—	—	—	—	88	1	36	1	—	—	22	2	—	175	2
Whitehall Reservoir,	795	547	175	—	—	—	—	41	5	110	1	—	—	28	13	—	789	6
Cedar Swamp,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Totals,	4,374	2,496	1,630	24	—	4	—	480	26	671	14	1	1	158	66	1,831	4,337	37
COCHRUTATE WATERSHED.																		
Snake Brook,	220	—	159	26	—	1	—	15	1	27	1	—	—	19	—	—	219	1
Pegan Brook,	1,084	773	248	3	—	—	—	32	—	72	—	—	—	19	13	1,018	1,084	—
Course Brook,	139	2	99	9	—	—	—	16	—	34	—	—	—	10	1	—	139	—
Beaver Dam Brook,	1,701	1,303	263	19	—	—	—	56	3	163	3	—	—	35	16	1	1,695	6
Totals,	3,144 ²	2,083	769	57	—	1	—	119	4	296	4	—	—	83	30	1,019	3,137	7

¹ On some premises there are two or more cases.² Including 187 summer dwellings.

Sudbury Watershed.

On the Sudbury watershed there were 4,849 premises at the beginning of the year and 4,874 at the end of the year, an increase of 25 premises during the year. This increase results from the construction of 30 buildings and the destruction by fire or removal of 5 buildings.

Cochituate Watershed.

On the Cochituate watershed there were 3,206 premises at the beginning of the year and 3,144 at the end of the year, a decrease of 62 premises during the year. This decrease results from the exclusion of 151 premises on the Dudley Pond watershed from the Cochituate system and the addition of 89 premises on this watershed during the year. The premises excluded at Dudley Pond include 46 permanent dwellings, 94 summer cottages and 11 other buildings. Seventy-three of the premises have wells, 70 use the public water supply and 88 have cesspools.

PROTECTION OF THE WATER SUPPLY.

Filtration and Chlorination.

On the Wachusett watershed the surface water from 525 acres in the village of Sterling has been filtered at the Sterling filter-beds. The sewage from the Worcester County Training School has been purified at the filter-beds on Beaman Street in West Boylston, and the sewage from five summer cottages at Sterling Junction was filtered at the Gates Terrace filter-beds from April 18 to November 4. The cost of maintaining all of these filters was \$591.14.

On the Sudbury watershed the surface water from an area of 2 square miles in Marlborough has been filtered at the Marlborough Brook filter-beds before entering the Sudbury Reservoir. Diluted sewage from the Marlborough main sewer was received at the combined storage reservoir and filter-bed on Farm Road from February 26 to 29, inclusive; March 27 to April 18, inclusive; April 28 and 29, May 7 to 9, inclusive, and June 17. The ground water from the sewer underdrain was received from March 1 to 11 and 19 to 22, inclusive, and on March 26, April 19 to 27, inclusive, and from May 7 to June 10, inclusive. The drainage from the Southborough swimming pool was filtered and the surface water from the Fay School

grounds in Southborough, and from Cherry Street Brook at Fayville was treated with calcium hypochlorite at times during the year when this treatment appeared to be desirable. The cost of the filtration and chlorination work on the Sudbury watershed was \$3,209.98.

On the Cochituate watershed the surface water from an area of about one square mile of the thickly settled portion of the town of Natick was pumped at the Pegan filter station and filtered before it was allowed to enter Lake Cochituate, with the exception, however, of the overflow from the intercepting reservoir from February 25 to 29, inclusive; March 26 to 31, inclusive; April 1 to 5, inclusive; April 9, 15, 16, 23, 29 and 30, May 17 and June 17, amounting to 20,000,000 gallons, all of which was treated with calcium hypochlorite. The pumping station was operated on 251 days during the year and 344,681,000 gallons, equivalent to an average of 942,000 gallons per day for the entire year was pumped to the filters. The cost of operating and maintaining the pumping station and filters was \$3,752.42, which is equivalent to a cost of \$10.89 per million gallons pumped.

Improvement of Swamps and Brooks.

The ditches maintained in the swamps on the watersheds for improving the quality of the water were cleaned and the weeds and brush were mowed for a width of 10 to 20 feet on both sides where necessary. The total length of these ditches is 36.49 miles, of which 27.55 miles have been cared for by the Wachusett Department, at a cost of \$1,291.21 for the usual cleaning and mowing and an additional cost of \$1,051.42 for repairing slopes and paving along the ditches tributary to the open channel and to the Sterling filter-beds for a length of 11.87 miles. The cost of the usual cleaning and mowing along the 8.94 miles of ditches which were cared for by the Sudbury Department was \$250.94.

An area of about $3\frac{1}{2}$ acres in Big Crane Swamp in Westborough, which was thickly grown with cedars, was thinned and improved at a cost of \$562.07, and 1,437 first class fence posts and a considerable amount of cord wood, with an aggregate value of about one-half the cost of the work, were obtained. The fence posts were retained for our own use and the cord wood was sold.

During the year E. W. Wheeler & Son of Berlin completed the

removal from an area of 105 acres in Big Crane Swamp of the standing and burned timber purchased in February, 1911.

The lanes cut in previous years along the boundary line of Cedar Swamp in the Sudbury Department were mowed for a length of 15,560 feet and new lanes were cut for a length of 3,040 feet.

The work of improving Gates Brook in the Wachusett watershed at the district known as "The Settlement" in West Boylston, which was undertaken in the latter part of 1915, was resumed July 31 and continued until November 18. The work done during 1916 includes the construction of 4 concrete culverts and 815 linear feet of open channel with standard board bottom, and side slopes rising 1 foot vertical in 2 feet horizontal paved with field stones for a vertical height of $1\frac{1}{2}$ feet. About one-third of the work is now finished and the expenditures during 1916 were \$2,842.03 for labor and \$446 for materials. The unit costs were \$1.26 per cubic yard for earth excavation and disposal, \$9.05 per cubic yard for concrete masonry in culverts, \$0.53 per square yard for stone paving and \$0.11 per linear foot for the board bottom. When the work is completed the water of the brook will be confined to the new channel and the flooding during wet weather of the adjoining swamp land on which a number of dwellings without proper drainage facilities have been built will be prevented, and satisfactory measures can be taken to prevent the pollution of the water supply.

Acquisition of Land.

For the protection of the water supply on the Wachusett watershed 21.02 acres of land located near the Waushacum Lakes in Sterling, 4.33 acres located near the Wachusett Reservoir in West Boylston and 0.421 of an acre located near Gates Brook in West Boylston have been acquired during the year.

CLINTON SEWAGE DISPOSAL WORKS.

Pumping Station.

The Clinton sewerage pumping station was operated daily and the quantity of sewage pumped to the filter-beds is equivalent to 1,225,000 gallons a day throughout the year, which is 284,000 gallons per day more than in 1915. The increase in pumping over the previous year appears to have been due to the leakage of ground water into the section of the town sewer which is located along the Nashua

River during the first half of the year when there was high water in the river. The quantity of sewage pumped in 1916 was nearly double the quantity pumped in 1900, when the works were put into operation. All of the sewage was pumped with the electric motor-driven 12-inch DeLaval centrifugal pump. The pumping statistics are as follows: —

Total pumpage (gallons),	448,205,000
Average pumpage (gallons per day),	1,225,000
Electric energy used (kilowatt hours),	145,466
Pumpage per kilowatt hour (gallons),	3,081
Average lift (feet),	48.1
Efficiency of pumping unit and transmission line (per cent.),	51.9
Coal used for burning sludge and heating (pounds),	86,005

Cost of pumping: —

Labor,	\$841 80
Electric energy at \$5.30 per thousand kilowatt hours,	770 97
Coal for burning sludge and heating,	167 01
Repairs and supplies,	214 92

Total for station,	\$1,994 70
------------------------------	------------

Cost per million gallons,	\$4 45
Cost per million foot gallons,	0.0925

The interior and exterior woodwork of the pumping station was painted and the slate roof was repaired. The building is now in good condition.

Filters.

The filters were operated in the same manner as during the previous year, with the settling basins out of service during the summer. While there appears to be some improvement in regard to the odors from the filtration area with the settling basins out of service, the purification of the sewage continues to be less efficient than when they are in use, and if the quantity of sewage to be filtered should be as large during the coming year as in 1916 it would seem to be desirable to use the settling basins throughout the year as formerly, although the odors from the filtration area may be occasionally somewhat objectionable with the settling basins in use. The cost of maintaining the filters during 1916 was as follows: —

Labor,	\$5,044 24
Supplies and expenses,	68 37
Total,	\$5,112 61
Cost per million gallons filtered,	\$11 43

The average results of chemical analyses of sewage and effluent from the filters for the year 1914, when the settling basins were used throughout the year, and for the years 1915 and 1916, with the settling basins out of service during the summer, are given in the following table:—

[Parts per 100,000.]

	1914.	1915.	1916.		
			January to June.	July to December.	Whole Year.
Albuminoid ammonia, sewage,	1.3775	1.4350	.5543	1.4967	1.0255
Albuminoid ammonia, effluent, . . . . .	.0758	.09347	.0845	.1122	.0983
Reduction, per cent.,	94	93.5	85	93	90
Oxygen consumed, sewage,	10.825	9.5333	5.10	10.30	7.70
Free ammonia, sewage,	4.1658	3.7867	1.8533	3.7167	2.7850
Free ammonia, effluent, . . . . .	.3345	.5924	.6059	1.4573	1.0316
Reduction, per cent.,	92	84	67	61	63
Nitrogen as nitrates, effluent,	1.0559	.7152	.2890	.4495	.3693
Iron, effluent, . . . . .	.0802	.30815	.559	1.545	1.052
Average quantity of sewage filtered, gallons per day.	1,022,000	941,000	1,557,800	894,500	1,225,000

Four of the six houses located on High Street in Lancaster, which were acquired in connection with the construction of the filters, were sold at auction on October 6. The three houses on the southeast side of the street, known as the Sonia, Lalone and Fuller houses, were sold for removal, and the Moisen house, located on the northwesterly side of High Street, on a lot of land entirely detached from the remaining water works land in the vicinity, was sold with the lot. The two McLean houses on the northwest side of High Street, which were retained, have been repaired and are now in good condition. One of them is occupied by one of the water works employees at the filter-beds and the other by a party having no connection with the works.

FORESTRY.

Wachusett Department.

An area of about 4 acres at the Wachusett Reservoir near the North Dike was planted with 3,400 3-year-old white pine seedlings from the North Dike nursery, and 9,100 3-year-old white pine seedlings from this nursery and 1,800 4-year-old white spruce seedlings from the Oakdale nursery were planted where previous plantings had failed in West Boylston and Sterling. The necessary attention was given to the Oakdale and North Dike nurseries.

Fifty thousand 2-year-old white pine seedlings, 50,000 2-year-old Scotch pine seedlings and 50,000 2-year-old red pine seedlings received from the State nursery at Amherst were set out at the Oakdale nursery, which at the end of the year contained the following:—

2-year-old white pine seedlings, in seed beds,	55,600
2-year-old white pine seedlings, in transplant beds,	49,700
2-year-old red pine seedlings, in transplant beds,	44,700
2-year-old Scotch pine seedlings, in transplant beds,	41,400
4-year-old red pine seedlings, in transplant beds,	120
2-year-old Norway pines,	200
5-year-old sequoias,	120
5-year-old white spruce seedlings, in transplant beds,	12,900
1-year-old tamarack seedlings, in seed beds,	9,600
1-year-old arbor vitæ seedlings, in seed beds,	400
	<hr/>
	214,740

Fifty-three thousand 2-year-old white pine seedlings from the State nursery at Amherst were set out at the North Dike nursery, which at the end of the year contained the following:—

2-year-old white pine seedlings, in transplant beds,	46,300
4-year-old white pine seedlings, in transplant beds,	94,000
	<hr/>
	140,300

To prevent the spread of the Chestnut Bark disease an area of $3\frac{1}{4}$ acres in West Boylston, grown largely with 25 and 30-year-old chestnut trees, was cleared at a net cost of about \$32.00 per acre. An improvement thinning was made in an area of about 22 acres

adjacent to the highway and about midway between Clinton and Boylston at a net cost of about \$9.00 per acre. Gray birch and other trees which interfered with the growth of the 5 to 10-year-old white pine trees were cut over an area of 93 acres in Boylston and West Boylston at a net cost of about \$8.60 per acre. The brush and weeds which interfered with the growth of the white pines planted in 1915 on 45 acres of land along the open channel were mowed and disposed of at a cost of \$5.90 per acre.

About 350 acres of land along the main highways about the Wachusett Reservoir and at the dam, which was known to be infested with gypsy moths, was sprayed with arsenate of lead between May 31 and July 11. This work was done with the power sprayer auto truck at a cost of \$1,263.19, and 6,700 pounds of arsenate of lead was used. During the latter part of the year the marginal lands at the reservoir were scouted for gypsy moth egg clusters, which were painted with creosote where found. At the close of the year about 2,000 acres of land had been covered and 143,100 egg clusters had been found and painted at a cost of \$818.00.

During July and August all of the plantings on the marginal lands around the reservoir were inspected for the pine tree weevil on two occasions. During the first inspection 5,900 leaders were cut and 2,050 during the second inspection. The cost of the work was \$258.30.

The entire cost of protecting the trees and plantings from insects and disease during the year was \$2,787.73.

The usual fire patrol service was maintained during the spring and fall. On May 11 two fires occurred which burned over about 80 acres of Water Works land in Clinton, Sterling and West Boylston. The damage done was slight as the growth on a large part of the area was of little value.

The brush, grass and weeds on $25\frac{1}{2}$ miles of the marginal fire guard, which is 40 feet wide, and on $31\frac{3}{4}$ miles of forest roads, which are 15 feet wide, were mowed and burned at a cost of \$2,063.13. A marginal strip 100 feet wide adjacent to the highways bordering the reservoir was improved for a length of $5\frac{1}{2}$ miles. The work covered an area of about 105 acres and cost \$16.30 per acre. The forest road around the Lily Ponds in West Boylston was repaired for a length of 650 feet at a cost of \$132.84.

The area of the Water Works land at the Wachusett Reservoir

which has been planted with trees since the field planting was begun in 1902 is 1,424 acres. The total expenditures for forestal work during the year in the Wachusett Department was \$9,981.23.

Sudbury Department.

At the Sudbury Reservoir 22 acres of land near Acre Bridge Road, 12 acres on Pine Hill, 2 acres on Farm Road and 3 acres on the east side of the reservoir north of Boston Road were prepared for planting at a cost of \$18.00 per acre.

In April and May 26,000 4-year-old white pine seedlings were set out near Acre Bridge Road, 4,000 near the Ball place and 8,700 on the east and west shores of the reservoir north of Boston Road. In May 5,800 4-year-old white pine seedlings were set out on the west shore at Ashland Reservoir and 2,400 4-year-old white pine seedlings were set out near the dam at Whitehall Reservoir and 2,600 on the west shore of this reservoir near Spring Street. About 1,400 5 to 7-year-old white pines, obtained from the woods, were set out on the slope between the Weston Aqueduct and the old Connecticut Path just east of Main Street in Wayland.

Early in the spring 50,000 2-year-old white pine seedlings, 50,000 2-year-old Scotch pine seedlings and 50,000 2-year-old red pine seedlings were received from the State nursery at Amherst and were set out at the nursery at the Sudbury Reservoir, which now contains the following:—

50,000 2-year-old white pine seedlings.

50,000 2-year-old red pine seedlings.

50,000 2-year-old Scotch pine seedlings.

50,000 3-year-old spruce seedlings.

The nursery received the necessary attention. One man was kept at work most of the time during the spring, summer and early fall.

Fire patrol service was maintained at times when the conditions were favorable for fires to spread rapidly, and where pine trees had been planted along the highways the dry grass and brush were mowed, or burned if conditions were favorable, between the highway and the plantings.

Six fires occurred at the Sudbury Reservoir and burned over areas ranging from $\frac{1}{10}$ of an acre to $3\frac{1}{2}$ acres. One of the fires was caused by sparks from a locomotive on the New York, New Haven

& Hartford Railroad; the cause of the others was not determined. About 7,700 white pines, ranging from 4-year-old seedlings to trees 5 feet in height, were injured or destroyed. The trees at the Sudbury and Framingham reservoirs, at Lake Cochituate and at the White place and siphon chamber No. 2 on the Weston Aqueduct were sprayed with arsenate of lead to protect them from the gypsy moth and other insects. A horse-drawn power sprayer was used for this work. It was in use 19 days at Sudbury Reservoir, 4 days at the Framingham Reservoirs, $11\frac{7}{8}$ days at Lake Cochituate and 2 days at the Weston Aqueduct. The total cost of the work was \$1,644.22 and 9,600 pounds of arsenate of lead was used.

Some time was spent scouting for gypsy moth egg clusters and painting them with creosote, and 120,200 clusters were painted at Sudbury Reservoir, 67,400 at the Framingham reservoirs, 900 at Ashland Reservoir, 17,800 along the Sudbury Aqueduct, 56,600 along the Cochituate Aqueduct and 20,900 along the Weston Aqueduct, making a total of 283,800 clusters found and painted at a cost of \$864.07. All of the trees except the pines along the Cochituate Aqueduct for a distance of 500 feet west of Oak Street in Natick were so badly infested by gypsy moths that they were cut down.

The plantings in this department were inspected for the pine tree weevil and the leaders were cut and destroyed wherever the weevils were found, and in some instances a second inspection was necessary. The cost of the work was about \$140.00.

The brown-tail moth caterpillars were destroyed within 50 feet of the highways at the Sudbury and Framingham reservoirs.

The total expenditures for forestal work in the Sudbury Department were \$6,229.77.

Distribution Department.

The gypsy and brown-tail moths and the elm leaf beetles were destroyed on the Water Works lands around the distribution reservoirs as in former years by spraying the foliage with arsenate of lead in June, by painting the gypsy moth egg clusters with creosote and cutting and burning webs of the brown-tail moth during the winter. The spraying was done with a horse-drawn power sprayer; an area of approximately 165 acres was covered and 7,110 pounds of arsenate of lead was used. The cost of the work was \$2,668.29.

Of the 300 4-year-old white spruce trees received from the Oakdale nursery 150 were set out on the Water Works land at Spot Pond

and the remainder were set out on the Water Works land near the Lawrence basin at Chestnut Hill Reservoir.

Some of the pine trees at the Weston Reservoir and Spot Pond were attacked by the pine-tree weevil and the leaders of the trees affected were cut off and destroyed. Some chestnut trees near the terminal chamber of the Weston Aqueduct were found to be affected by the chestnut bark disease and were cut down and disposed of.

The total expenditures for forestal work in the Distribution Department amount to about \$2,800.00.

HYDRO-ELECTRIC SERVICE.

Wachusett Power Station.

The hydro-electric station at the Wachusett Dam in Clinton was operated on 297 days during the year. From January 1 to October 1 the energy not used in connection with the operation of the Metropolitan Water Works was sold to the Connecticut River Transmission Company under contract dated September 14, 1910. Since the termination of this contract on September 30, 1916, energy has been sold to the New England Power Company¹ at the price formerly received under the contract, in accordance with an agreement made September 30, which provides that until the new contract between the Board and the New England Power Company and the Edison Electric Illuminating Company of Boston becomes effective, the New England Power Company will take as much energy from the Wachusett power station as it can reasonably and properly use without wasting water at its own plants. Since the beginning of the five-year period of the contract with the Connecticut River Transmission Company the portion of the total quantity of water discharged into the Wachusett Aqueduct from the Wachusett Reservoir that was used for the generation of electric energy has been as follows: —

	Per Cent.
Contract year 1911-1912,	79.5
Contract year 1912-1913,	83.2
Contract year 1913-1914,	98.4
Contract year 1914-1915,	93.5
Contract year 1915-1916,	77.7
3 months period ending Dec. 31, 1916, under agreement of Sept. 30,	92.3

¹ The Connecticut River Transmission Company has been consolidated with the New England Power Company.

The Wachusett power station statistics for the year 1916 are as follows: —

Total energy developed (kilowatt hours),	6,465,810
Energy used at power station (kilowatt hours),	13,144
<hr/>	
Available energy (kilowatt hours),	6,452,666
Water used (gallons),	29,626,000,000
Average head (feet),	99.64
Energy developed per million foot gallons (kilowatt hours), .	2.19
Efficiency of station (per cent.),	69.70
Credits: —	
Energy sold Connecticut River Transmission Company 6,307,200 kilowatt hours at \$.0053,	\$33,428 16
Labor furnished Connecticut River Transmis- sion Company,	32 50
Energy furnished Clinton sewerage pumping station, 145,466 kilowatt hours at \$.0053, .	770 97
<hr/>	
	\$34,231 63
Charges: —	
Superintendence,	\$750 00
Labor, operating station,	4,431 88
Repairs and supplies for station,	626 84
<hr/>	
	\$5,808 72
Taxes,	3,025 00
Administration, general supervision, interest and sinking fund,	5,800 00
<hr/>	
	14,633 72
<hr/>	
Profit,	\$19,597 91
Cost of available energy per thousand kilowatt hours,	\$2.268

Sudbury Power Station.

A portion of the hydro-electric machinery at the Sudbury Power station was put into regular service on September 14 and the entire plant has been in service since November 26. The entire output, with the exception of a small amount of energy used for lighting the station and operating the electrically driven accessories, has been sold

to the Edison Electric Illuminating Company of Boston under a contract dated December 21, 1914. The station is not regularly operated on Sundays or legal holidays. Between September 14, when it was started, and the end of the year the station was operated on 90 days, and since November 26 all of the water discharged from the Sudbury Reservoir has been used for the generation of electric energy.

The Sudbury power station statistics since September 14, 1916, when it was put into service, are as follows:—

Total energy developed (kilowatt hours),	1,070,660
Energy used at power station (kilowatt hours),	4,546

Available energy (kilowatt hours),	1,066,114
--	-----------

Framingham Reservoir No. 3 service:—

Water used (gallons),	4,778,700,000
Average head (feet),	65.70

Weston Aqueduct service:—

Water used (gallons),	3,615,540,000
Average head (feet),	39.20

Energy developed per million foot gallons (kilowatt hours), .	2.35
Efficiency of station (per cent.),	74.80

Credit:—

Energy sold Edison Electric Illuminating Company of Boston, 1,066,114 kilowatt hours at \$.00625,	\$6,663 21
--	------------

Charges:—

Superintendence,	\$300 00
Labor, operating station,	1,844 71
Repairs and supplies for station,	132 82

\$2,277 53

Administration, general supervision, interest and sinking fund, for 3 months,	1,325 00
--	----------

3,602 53

Profit (for one quarter year only),	\$3,060 68
---	------------

Cost of available energy per thousand kilowatt hours,. . . .	\$3.379
--	---------

DISTRIBUTION PUMPING SERVICE.

The total quantity of water pumped at the five distribution pumping stations during the year is 22,039,270,000 gallons, which is 5,667,030,000 gallons, or 20.45 per cent., less than the quantity pumped in 1915, although the total quantity of water supplied to the District was 4.3 per cent. greater in 1916 than in 1915. The reduction in the quantity of water pumped was due to putting the new 60-inch Weston Aqueduct Supply Main into service on February 8. This increased the quantity of water delivered by gravity into the low-service distribution system by about 19,000,000 gallons per day and made a corresponding decrease in the quantity pumped for the low service after that date.

The total cost of operating all the stations during the year was \$97,839.91, which is \$992.70 more than in 1915. An analysis of the cost of pumping for the various services during the year as compared with the cost in 1915 shows a reduction for the low service, due to having the new 60-inch Weston Aqueduct Supply Main in service, of \$2,344.76 for labor and of \$2,583.62 for fuel, notwithstanding the increased price of coal. The reduction in cost for both of these items for the low service is \$4,928.38, while there was an increase of \$1,344.34 for labor and of \$1,386.67 for fuel in all of the other services, and an increase of \$2,557.36 for repairs and of \$632.71 for oil and supplies in all services, or a total increase of \$5,921.08 for these items.

Wages have remained the same during the year as in 1915 but there was an increase of from 7 to 11 per cent. in the price of coal purchased for the various stations under the 1916 contracts as compared with the prices paid under the 1915 contracts. There was also a material increase in the price of supplies purchased during the year as compared with the prices paid in 1915.

The amount of coal furnished by various parties at the pumping stations and the cost of the coal is as follows: —

DEALERS.	STATIONS (AMOUNT IN GROSS TONS).					Cost per Gross Ton in Bins. ¹
	Chestnut Hill No. 1.	Chestnut Hill No. 2.	Spot Pond.	Arlington.	Hyde Park.	
E. Russell Norton, bituminous,	118.75	-	-	-	-	\$4 49
E. Russell Norton, bituminous,	-	1,679.74	-	-	-	4 35
H. N. Hartwell & Son, Inc., bituminous,	537.41	-	-	-	-	4 16
H. N. Hartwell & Son, Inc., bituminous,	-	2,076.83	-	-	-	4 05
C. W. Claflin & Co., anthracite-buckwheat,	113.44	-	-	-	-	3 36
C. W. Claflin & Co., anthracite-buckwheat,	-	284.42	-	-	-	2 85
C. W. Claflin & Co., anthracite-buckwheat,	-	913.57	-	-	-	3 02
Bader Coal Co., bituminous,	-	-	279.49	-	-	5 08
Hetherington & Co., bituminous,	-	-	267.53	-	-	5 43
E. Russell Norton, bituminous,	-	-	153.40	-	-	6 52
Locke Coal Co., anthracite-screenings,	-	-	452.10	-	-	3 00
Hetherington & Co., bituminous,	-	-	-	214.38	-	4 22
Garfield & Proctor Coal Co., bituminous,	-	-	-	313.59	-	4 52
H. N. Hartwell & Son, Inc., bituminous,	-	-	-	-	45.36	4 79
Garfield & Proctor Coal Co., bituminous,	-	-	-	-	51.65	4 33
Sawtelle Coal Co., anthracite-screenings,	-	-	-	-	9.19	3 64
Sawtelle Coal Co., anthracite-screenings,	-	-	-	-	95.44	3 36
Wm. H. Harlow & Sons, anthracite-screenings,	-	-	-	-	69.19	3 36
Total, bituminous,	656.16	3,756.57	700.47	527.97	97.01	-
Total, anthracite-buckwheat,	113.44	1,197.99	-	-	-	-
Total, anthracite-screenings,	-	-	452.10	-	173.82	-
Average cost, bituminous: —						
In bins,	\$4 22	\$4 18	\$5 55	\$4 40	\$4 57	-
On cars,	4 01	4 09	-	4 30	4 44	-
Average cost, anthracite-buckwheat: —						
In bins,	3 36	2 98	-	-	-	-
On cars,	3 09	2 89	-	-	-	-
Average cost, anthracite-screenings, in bins,	-	-	3 00	-	3 37	-

¹ Includes cost of unloading coal from cars and all expenses incidental to storage of the coal.

All bituminous coal was purchased under specifications which provide for a variation in price with variation in heat units and ash as determined by analysis. The price per ton was reduced 2 cents for each 50 heat units or fraction thereof less than 14,700 per pound of dry coal, and 1 cent for each $\frac{1}{2}$ of 1 per cent, or fraction thereof of ash in the dry coal in excess of 8 per cent. For each 50 heat units or fraction thereof in excess of 14,800 per pound of dry coal the price per ton was increased 1 cent. The results of analyses of the bituminous coal purchased during 1916 are as follows:—

KIND OF COAL.	Number of Samples tested.	British Thermal Units.	Percent- age of Volatile Matter.	Percent- age of Ash.	Percent- age of Moisture.	Percent- age of Fixed Carbon.
Alpha Special,	29	14,708	20.98	7.04	4.10	71.98
Davenport,	23	14,807	18.86	6.48	2.61	74.66
Brazil Smokeless, . . .	9	14,376	20.35	9.11	3.13	70.54
Peacock,	9	14,198	21.10	10.22	2.26	68.68
New River,	5	14,764	17.03	6.75	2.38	76.22
Ideal,	1	13,935	17.00	11.26	1.94	71.74
Wendell,	1	14,330	20.40	9.23	1.62	70.37

Chestnut Hill Pumping Stations.

The quantity of water pumped at the Chestnut Hill pumping stations into the southern high-service mains averaged 34,371,300 gallons per day during 1916, or 2,019,300 gallons per day more than in 1915. The cost per million gallons of water pumped in 1916 was 5.45 cents less than during the previous year although the cost of pumping for the southern high service in 1916 exceeded the cost in 1915 by \$547.50 for labor, \$551.12 for fuel, \$259.98 for repairs and \$365.13 for oil, waste and supplies.

The southern high-service pumping statistics for 1916 are as follows:—

	PUMPING STATION No. 1.			PUMPING STATION No. 2.	Totals.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.	
Daily pumping capacity (gallons), . . .	16,000,000	20,000,000	30,000,000	40,000,000	106,000,000
Total quantity pumped (million gallons), . .	156.09	5.48	1,334.27	11,084.07	12,579.91
Daily average quantity pumped (gallons), . .	426,500	15,000	3,645,500	30,284,300	34,371,300
Coal used in pumping (pounds),	401,085	4,805	852,810	7,417,190	8,675,890
Gallons pumped per pound of coal,	389.17	1,140.48	1,564.56	1,494.38	1,449.98
Average lift (feet),	134.54	116.40	119.56	124.54	124.13
Cost of pumping: —					
Labor,	\$1,381 98 ¹	\$44 35 ¹	\$6,003 63 ¹	\$11,743 41 ²	\$19,173 37
Fuel,	1,308 05	9 12	1,536 88	13,228 71	16,082 76
Repairs,	246 88	7 94	1,072 39	1,033 80	2,361 01
Oil, waste and packing,	12 60	41	253 36	340 05	606 42
Small supplies,	47 93	1 54	208 23	117 03	374 73
Totals,	\$2,997 44	\$63 36	\$9,074 49	\$26,463 00	\$38,598 29
Cost per million gallons pumped,	\$19.2033	\$11.5620	\$6.8011	\$2.3875	\$3.0682
Cost per million gallons raised 1 foot high, .	.1427	.0993	.0569	.0192	.0247

¹ Operating and care of station.² Includes operating labor only.

The low-service pumping was continued in the same manner as during 1915 until February 8, when the new 60-inch Weston Aqueduct Supply Main was put into service. During 1915 about 34,000,000 gallons of water per day was supplied to the southern low service by gravity from the Weston Aqueduct Supply Mains and the remainder of the southern low-service supply and all of the water required for the northern districts was pumped at Chestnut Hill into the Spot Pond service, the portion supplied to the southern low service being by-passed to that service as required, by operating the hydraulic valves at the pumping stations. Since February 8 all of the water for the Spot Pond service and for a portion of the southern low-service supply has been furnished from the Weston Aqueduct Supply Mains by gravity, and the remainder of the southern low-service supply has been pumped at Chestnut Hill. By this arrangement the quantity of water pumped for the low-service has been reduced to less than one-half the quantity formerly pumped and the head pumped against has been reduced about 8 feet.

On account of this change the cost per million gallons of water pumped during 1916 is \$1.80 more than in 1915, but the cost of labor has been reduced \$2,344.76, of fuel \$2,583.62 and of oil and waste \$66.55 as compared with the cost in 1915, and the total cost of pumping for the low service is \$3,980.80 less than during 1915.

The low-service pumping statistics for 1916 are as follows: —

	Chestnut Hill Pumping Station No. 2. — Engines Nos. 5, 6 and 7.
Daily pumping capacity each engine (gallons),	35,000,000
Quantity pumped (gallons):	
Jan. 1 to Feb. 7, inclusive,	1,287,250,000
Feb. 8 to Dec. 31, inclusive,	5,039,700,000
Total,	6,326,950,000
Daily average quantity pumped (gallons):	
Jan. 1 to Feb. 7, inclusive,	33,875,000
Feb. 8 to Dec. 31, inclusive,	15,365,000
Total coal used (pounds),	3,217,295
Gallons pumped per pound of coal,	1,966.54
Average lift (feet):	
Jan. 1 to Feb. 7, inclusive,	41.51
Feb. 8 to Dec. 31, inclusive,	33.70
Cost of pumping: —	
Labor,	\$16,804 75 ¹
Fuel,	5,612 72
Repairs,	3,266 11
Oil, waste and packing,	271 46
Small supplies,	228 42
Total,	\$26,183 46
Cost per million gallons pumped,	\$4.1384
Cost per million foot gallons, . . . . .	.1173

Spot Pond Pumping Station.

All of the water supplied to the northern high-service district during the year was pumped at the Spot Pond pumping station, with the exception of the supply for the towns of Swampscott and Nahant from 11.30 A.M. April 23 to 11.30 P.M. April 24, while a break in the 16-inch northern high-service main at Fox Hill bridge was being repaired. The quantity of water pumped at this station averaged 7,106,000 gallons per day during 1916, which is an increase of 328,000 gallons per day over the previous year. The total cost of

¹ Includes operating labor and all labor employed in care of Station No. 2.

operating the station was \$634.38 more while the cost per million gallons of water pumped in 1916 was 4.24 cents less than in 1915.

The northern high-service pumping statistics for 1916 are as follows:—

Total quantity pumped (gallons),	2,600,820,000
Daily average quantity pumped (gallons),	7,106,000
Total coal used (pounds),	2,391,339
Gallons pumped per pound of coal,	1,087.60
Average lift (feet),	129.06
Engine No. 8 operated (hours),	94
Engine No. 9 operated (hours),	3,060
Quantity pumped by Engine No. 8 (gallons),	41,360,000
Quantity pumped by Engine No. 9 (gallons),	2,559,460,000

Cost of pumping:—

Labor,	\$9,632 74
Fuel,	4,812 44
Repairs,	241 16
Oil, waste and packing,	285 40
Small supplies,	188 24
Total for station,	\$15,159 98
Cost per million gallons pumped,	\$5.8289
Cost per million foot gallons, . . . . .	.0452

Arlington Pumping Station.

All of the water for the northern extra high-service district was pumped at the Arlington pumping station. The quantity pumped averaged 797,000 gallons per day, which is an increase of 110,000 gallons per day, or 16 per cent. over the previous year, and there was an increase of \$2,196.65, or more than 26 per cent. in the cost of operating the station, of which \$334.42 was for labor, \$536.56 for fuel, \$1,285.55 for repairs and \$40.12 for supplies.

The northern extra high-service pumping statistics for 1916 are as follows:—

Total quantity pumped (gallons),	291,880,000
Daily average quantity pumped (gallons),	797,000
Total coal used (pounds),	1,266,555
Gallons pumped per pound of coal,	230.45
Average lift (feet),	281.70
Engine No. 10 operated (hours),	5,864
Engine No. 11 operated (hours),	698
Quantity pumped by Engine No. 10 (gallons),	270,850,000
Quantity pumped by Engine No. 11 (gallons),	21,030,000

Cost of pumping: —

Labor,	\$6,356 12
Fuel,	2,501 19
Repairs,	1,573 00
Oil, waste and packing,	56 39
Small supplies,	144 93
<hr/>	
Total for station,	\$10,631 63
Cost per million gallons pumped,	\$36.4247
Cost per million foot gallons, . . . . .	.1293

Hyde Park Pumping Station.

All of the water for the southern extra high-service district was pumped at the Hyde Park station. The quantity pumped averaged 655,000 gallons per day, which is 33,000 gallons per day less than in 1915, but owing to the increased cost of labor, fuel, repairs and supplies the total cost of operating the station was \$418.74 more than during the previous year.

The southern extra high-service pumping statistics for 1916 are as follows:—

Total quantity pumped (gallons),	239,710,000
Daily average quantity pumped (gallons),	655,000
Total coal used (pounds),	560,753
Gallons pumped per pound of coal,	427.48
Average lift (feet),	131.00
Engine No. 13 operated (hours),	3,554
Engine No. 14 operated (hours),	732
Quantity pumped by Engine No. 13 (gallons),	193,660,000
Quantity pumped by Engine No. 14 (gallons),	46,050,000

Cost of pumping: —

Labor,	\$5,797 17
Fuel,	995 56
Repairs,	166 62
Oil, waste and packing,	114 17
Small supplies,	193 03
<hr/>	
Total for station,	\$7,266 55
Cost per million gallons pumped,	\$30.3139
Cost per million foot gallons, . . . . .	.2314

Additional information regarding the operation of the pumping engines at the various stations is given on pages 165 to 174.

DISTRIBUTION RESERVOIRS.

The locations, capacities and elevations of the distribution reservoirs of the Metropolitan Water Works are shown by the following table: —

DISTRIBUTION RESERVOIRS AND LOCATIONS.	Elevation of ¹ High Water.	Capacity in Gallons.
Low Service: —		
Spot Pond, Stoneham and Medford,	163.00	1,791,700,000
Chestnut Hill Reservoir, Brighton District of Boston,	134.00	300,000,000
Weston Reservoir, Weston,	200.00	200,000,000
Mystic Reservoir, Medford,	157.00	26,200,000
Northern High Service: —		
Fells Reservoir, Stoneham,	271.00	41,400,000
Bear Hill Reservoir, Stoneham,	300.00	2,450,000
Northern Extra High Service: —		
Arlington Standpipe, Arlington,	442.00	550,000
Southern High Service: —		
Fisher Hill Reservoir, Brookline,	251.00	15,500,000
Waban Hill Reservoir, Newton,	264.50	13,500,000
Forbes Hill Reservoir, Quincy,	192.00	5,100,000
Forbes Hill Standpipe, Quincy,	251.00	330,000
Southern Extra High Service: —		
Bellevue Reservoir Steel Tank, West Roxbury District of Boston,	375.00	2,500,000
Total,	—	2,399,230,000

¹ Elevation in feet above Boston City Base.

By arrangement with the city of Chelsea a portion of the maintenance of its reservoir on Powder Horn Hill is assumed by the department, and the reservoir is used by the department when necessary in connection with the supplying of water to the northern high-service district. This reservoir has a capacity of 1,000,000 gallons with high-water line at elevation 196.6. The reservoir was in service from January 1 to April 10 and was kept full for emergency use during the remainder of the year.

Water is delivered into the Chestnut Hill Reservoir from the storage reservoirs by gravity and is pumped from that reservoir for the low-service and southern high-service districts.

Water is delivered from the Sudbury Reservoir through the Weston Aqueduct by gravity and is then supplied to the low-service works through the Weston Aqueduct Supply Mains by gravity.

Water for the northern high-service district is pumped from Spot Pond to the Fells and Bear Hill reservoirs. For the northern extra high-service district it is pumped from the low-service pipe lines to the steel tank at Arlington Heights and for the southern extra high-service it is pumped from the southern high-service pipe lines to the Bellevue Reservoir.

Weston Reservoir.

At the Weston Reservoir the inlet chamber, open channel, reservoir lands and screen chamber were cared for with the usual force, and the walks, driveways, drains and fences were given the necessary attention.

Since the Sudbury power station was put into service in September, the elevation of the water in the reservoir has been allowed to vary through a considerable range in order to utilize the water supplied to the best advantage for the generation of electric energy. To insure the satisfactory operation of the works in this manner a private telephone and electric recording gage service was installed between the screen chamber and the attendant's residence on Newton Street.

As it was considered desirable to dispose of the department house on Ash Street it was sold at public auction on July 6, and was later moved off the Water Works land.

The driveway leading to the screen chamber from Newton Street was resurfaced with pea stone and four concrete posts were set at the entrance so that it could be closed to the public whenever the attendant is not on duty by means of chains stretched between the posts.

Sixteen new screens were provided for use at the screen chamber to replace the old screens which were no longer suitable for use.

Chestnut Hill, Fisher Hill and Waban Hill Reservoirs.

The regular work of caring for the gate-houses and screens, shrubs, walks, drives and grounds at the Chestnut Hill, Fisher Hill and Waban Hill reservoirs was attended to as usual.

The portion of the driveway between the Lawrence and Bradlee basins at the Chestnut Hill Reservoir included within the boundaries

of the Water Works property, and having an area of about 8,000 square yards, was resurfaced with tarvia macadam at a cost of \$0.25 per square yard. Broken stone for this work was obtained from the storage pile at the east portal of the pressure tunnel on the line of the 60-inch Weston Aqueduct Supply Main, the only expense in connection therewith being for teaming. The old wooden fence along Beacon Street south of Bradlee basin was replaced with a new fence consisting of 8-inch x 8-inch concrete posts spaced 10 feet on centres with 2-inch iron pipe rails for a length of 1,572 feet, at a cost of \$0.90 per linear foot.

During the latter part of the summer foundations were constructed by the department force for a garage which is being built near the stable at the Chestnut Hill Reservoir for the department automobiles, in accordance with the new regulations of the Fire Prevention Commissioner. A contract for the superstructure of the garage was made with Crowley & Hickey of Boston on September 29. The basis of award was \$8,018 and about 25 per cent. of the work was completed at the end of the year. The garage will be a one-story structure about 17 feet in height with a main room on the front about 22 feet wide x 60 feet in length with a turntable 15 feet in diameter in the centre of the room opposite the entrance and space for two automobiles on each side of the entrance. The rear portion of the building is about 21 feet wide x 54 feet in length and is subdivided into office rooms, repair room, wash room, storage room and a room for the heating plant. The exterior of the front portion of the building is of Weymouth seam face granite with pean hammered split seam face and brick trimmings, and the exterior of the rear portion of the building is of red brick. The building will have an artificial stone cornice and a flat reinforced concrete slab roof supported by 12-inch I beams and covered with tar and gravel roofing. All exterior walls are to be backed with 8-inch interlocking tile. The partition walls are to be of concrete.

The Lawrence basin of the Chestnut Hill Reservoir which had been shut off and not used in connection with the operation of the water works since October 10, 1913, because of the stagnation which occurred with no flow into it from the Cochituate Aqueduct, was put into service again May 8, and circulation has been maintained by arranging the gates and stop-planks so that some of the water from the Sudbury Aqueduct flows through it in a reverse direction

from the normal flow when the Cochituate Aqueduct is in service. Under the present arrangement only a sufficient quantity of water to maintain circulation in the conduits is allowed to flow directly from the terminal chamber to the pump wells and about 35 per cent. of the remainder flows into the Lawrence basin, passes through a short section of the Cochituate Aqueduct and enters the Bradlee basin at the intermediate gate-house. The rest of the water is discharged directly into the Bradlee basin from the terminal chamber, and substantially all of the water pumped is now drawn from this basin.

The pumping stations and the stable at Chestnut Hill Reservoir were kept in repair and the lawns and grounds in the vicinity were kept in good condition.

Spot Pond, Fells and Bear Hill Reservoirs.

The usual attention was given to the gate-houses and screens at Spot Pond, Fells and Bear Hill reservoirs and to the protection of the trees and care of the Water Works lands at Spot Pond. A new motor boat of the V bottom runabout type, 21 feet in length, with 5 feet beam and 4 cylinder, 4 cycle Hermann engine was purchased to replace the old motor boat which was in unsatisfactory condition and was disposed of in connection with the purchase of the new boat.

Analyses made by the State Department of Health of the water from the spring at Porter Cove at the south end of the pond, which was used freely by many of the visitors, showed that it was unfit for drinking purposes, and when notified of the results the Metropolitan Park Commission removed the pump and stopped all use of the water on September 2.

The basement of the house on the east shore of the pond, owned by the department, was cleaned and whitewashed and additional lockers were installed therein for the use of the water works patrolmen. Minor repairs were made at the barn. The interior of the gate-houses and the boat-house and tool-house were painted. The lawn at the pumping station was regraded and seeded.

Arlington, Bellevue, Forbes Hill and Mystic Reservoirs.

The Arlington standpipe was drained for examination on October 3 and a layer of silt about 2 inches in depth was removed from the bottom. The inspection showed that it would be necessary to paint

the tank at an early date. It was refilled and put into service October 6, and some repairs were made on the stairs leading to the top of the tank. The grounds about the standpipe are cared for by the Public Works Department of the town of Arlington under an agreement with this department.

At the beginning of the year the Bellevue Reservoir was out of service in connection with the construction of the masonry tower around the tank. Water was turned into the reservoir on April 17 and it was put into regular service on April 20. In October the 16-inch connection with the Boston Water Works mains was made and 125 feet of 12-inch Boston Water Works main was lowered to conform to the grade in front of the reservoir.

The standpipe at Forbes Hill has been in service throughout the year and the reservoir has been kept full of water for emergency use. The gate-house has been cleaned and painted and the concrete lining of the reservoir has been repaired near high-water line, where injured by ice. The iron stairway leading to the top of the tower was scraped and painted.

The Mystic Reservoir was not in service during the year but was kept full of water for emergency use. The steps leading to the top of the embankment were painted and the roadway and walk were repaired where necessary.

Mystic Lake, Conduit and Pumping Station and Grounds at Arlington and Hyde Park Pumping Stations.

Although the Mystic Lake, conduit and pumping station are no longer in use for water supply they have received such attention as is necessary to maintain them in proper condition. At the lake the gate-house was painted, the bridge at the dam was repaired and the stone masonry abutments and piers were pointed. Fence posts were set along the boundary line of the water works land on the west shore of the lake for a distance of 1,284 feet and Wheelock wire fencing was strung for a distance of 458 feet. The fence will be completed as soon as the remainder of the wire is available.

At the premises near the pumping station the barn was painted and the stable was repaired and is ready for painting.

The lawns, shrubs, walks and drives at the Arlington and Hyde Park pumping stations have been kept in good condition.

DISTRIBUTION PIPE LINES.

The length of the distribution pipe lines owned and operated by the department at the close of the year is 122.27 miles, an increase of 0.03 of a mile during the year.

In connection with the maintenance of the pipe lines they have been regularly patrolled and the work of municipalities and public service corporations in the vicinity of the pipe lines has been inspected. The location of each valve chamber has been plainly stencilled on objects along the lines so that any valve can be found readily when desired. The valves have been kept in good working condition, and valve chambers have been cleaned and the frames and covers have been regulated to conform to grades of the streets where necessary. The covers over important valves have been covered with salt during cold weather to keep them free from ice.

The 60-inch Weston Aqueduct Supply Main in Commonwealth Avenue in Newton, between the Charles River and Valentine Street was tested in January and put into service February 8. The work of repairing several lawns and a tennis court which were damaged by the break which occurred in November, 1915, in the 48-inch Weston Aqueduct Supply Main, which could not be done satisfactorily last year was completed early in the spring.

On the Clinton Road 48-inch pipe line in Brookline the fence which was partially constructed last year, to enclose the water works land, was completed and the land was graded and seeded. The work of repairing the damage claimed to have been caused to property at No. 171 Clinton Road by the break which occurred in this line in December, 1913, was completed during the year to the satisfaction of the owner, with the exception of slight repairs to a concrete driveway and the cement plaster on the house, which will be completed as soon as the weather is favorable.

A 36-inch valve was set in the 48-inch low-service Longwood Avenue line at Coolidge Corner, Brookline, in April, so that the portion of this line between the Chestnut Hill Reservoir and Coolidge Corner can be used on the Boston or the Spot Pond service, as desired. The cost of the work was \$1,714.22.

Pipe Bridges.

During the year repairs were made to the pipe bridges over steam railroad tracks at Chestnut Hill Avenue, Brookline; College Avenue, Medford; Massachusetts Avenue, Cambridge, and Walnut Street, Somerville. Minor repairs were made to the pipe box at the Chelsea North Bridge over the Mystic River and the exterior of the bridge over the Mystic River at Governors Avenue, Medford, was painted.

Pipe Yards.

Pipe yards have been maintained at the Chestnut Hill Reservoir and near the Glenwood Station of the Boston & Maine Railroad in Medford as in former years. At the Chestnut Hill yard the floor of the long open shed was surfaced with cinders and is now used for storing the materials from the carriage shed which was torn down to provide space for the new garage. At the Glenwood yard minor repairs were made to the buildings, all the woodwork was painted and the valve shed was completed.

Meters, Regulating Valves and Recording Pressure Gages.

There are now 68 Venturi meters varying in size from 6 inches to 60 inches in diameter; 5 Hersey detector meters, 3 Hersey disc meters and 1 Hersey torrent meter connected with the distribution mains, which, with the exception of 10 of the Venturi meters, were used for measuring the water supplied to the various municipalities in the Metropolitan Water District. In connection with the operation of these meters two men were employed continuously during the year. The Venturi meter registers were read and the clocks were wound twice each week, and they were given such additional attention as was necessary to keep them in repair and operating satisfactorily.

There are now 8 pressure regulating valves installed in the distribution mains for reducing the pressure of the water supplied to portions of Chelsea, East Boston and Hyde Park and to Nahant, Revere, Swampscott and Winthrop. They have received the usual attention and have controlled the pressures in a satisfactory manner. The regulating valve at Beach Street, Revere, was in service from

December 22 to the end of the year, while the Winthrop valve was being repaired.

Recording pressure gages have been maintained at 22 stations on the Metropolitan Water Works, and the table on pages 198 and 199, showing the elevation of the hydraulic grade line in feet above Boston City Base at 19 of these stations for each month during the year has been prepared from the charts.

Breaks and Leaks.

On April 23 a break occurred in the 16-inch northern high-service main at the Fox Hill Bridge on the north side of the Saugus River in Lynn. The break was caused by the settlement of the pipe upon the stone abutment of the bridge, where the ground had been disturbed by the work of rebuilding the bridge in 1912. The pipe line which supplies water for Nahant and Swampscott was out of service from 11.30 A.M. April 23 to 11.30 P.M. April 24, and during this time water was furnished to these towns from the Lynn Water Works through the emergency connection at the junction of Broad and Washington streets. The cost of repairing the break was \$211.36 and \$52.11 was paid to the city of Lynn for 521,100 gallons of water furnished while the pipe line was out of service.

There were 58 leaks repaired in the distribution mains during the year at a cost of \$1,643.16. Of these leaks 12 were at wooden insulating joints, which were repaired at a cost of \$258.94. The services of a diver were required for repairing three leaks which were discovered in the 36-inch submerged pipe line under the Charles River at the Magazine Street crossing, in January. The cost of this work was \$408.47.

Leaks occurred under the Boston & Albany Railroad tracks at the Longwood, Allston and Cottage Farm crossings, and under the Boston & Maine Railroad tracks at Washington Street, Malden, and Second Street, Everett. At the Longwood crossing it was necessary to support the tracks with timbers before the excavation was made, and the cost of the work at this place was \$200.33.

Emergency Pipe Line Service.

Two $\frac{3}{4}$ -ton auto trucks, equipped with special bodies and gate operating attachments, were put into service early in the summer for operating valves quickly in case of emergency. One of the

trucks is stationed at the Chestnut Hill pipe yard in Brighton, for the southern division, and the other is stationed at the Glenwood pipe yard in Medford, for the northern division of the distribution pipe system, and men are kept on duty ready to operate the trucks in case of emergency at any time during the day or night.

CONSUMPTION OF WATER.

The total quantity of water furnished to the 18 municipalities supplied from the Metropolitan Water Works during the year, as measured by the water works meters, was 38,919,623,000 gallons, which is equivalent to an average consumption of 106,337,800 gallons per day. On the basis of an estimated population of 1,190,220 this is equivalent to a consumption of 89 gallons per capita per day. The increase of one gallon per capita, or about $1\frac{1}{4}$ per cent., in the average daily per capita consumption during 1916 over the consumption in 1915 appears to be due largely to climatic and industrial conditions and is probably only temporary.

From an inspection of the consumption diagrams following page 100 it appears probable that a further reduction in the per capita consumption will result from the installation of additional meters. It also appears to be possible to make an appreciable reduction in consumption by taking measures to detect and reduce the leakage from the main pipes.

The average daily consumption of water in each of the municipalities supplied from the Metropolitan Water Works during 1915 and 1916, as measured by the Metropolitan Water Works meters, is as follows:—

	Estimated Popula- tion, 1916.	AVERAGE DAILY CONSUMPTION.				
		1915.		1916.		Increase in Gallons.
		Gallons.	Gallons per Capita.	Gallons.	Gallons per Capita.	
Boston,	762,700	77,651,800	104	80,358,800	105	2,707,000
Somerville,	89,190	5,807,100	67	6,183,600	69	376,500
Malden,	50,160	2,243,000	46	2,460,200	49	217,200
Chelsea,	45,020	2,901,400	66	3,070,900	68	169,500
Everett,	38,870	2,599,100	68	2,891,400	74	292,300
Quincy,	42,030	2,511,800	61	2,499,400	59	12,400 ¹
Medford,	32,080	1,245,200	40	1,487,000	46	241,800
Melrose,	17,260	851,500	50	781,800	45	69,700 ¹
Revere,	26,790	1,484,800	58	1,591,200	59	106,400
Watertown,	17,280	1,025,200	62	1,125,500	65	100,300
Arlington,	15,670	825,300	55	929,400	59	104,100
Milton,	8,850	338,900	39	371,300	42	32,400
Winthrop,	13,470	700,300	54	707,800	53	7,500
Stoneham,	7,590	373,700	50	437,900	58	64,200
Belmont,	8,560	425,400	52	447,800	52	22,400
Lexington,	5,680	358,700	64	389,400	69	30,700
Nahant,	1,440	161,900	116	159,000	110	2,900 ¹
Swampscott,	7,580	436,400	59	445,400	59	9,000
District,	1,190,220	101,941,500	88	106,337,800	89	4,396,300

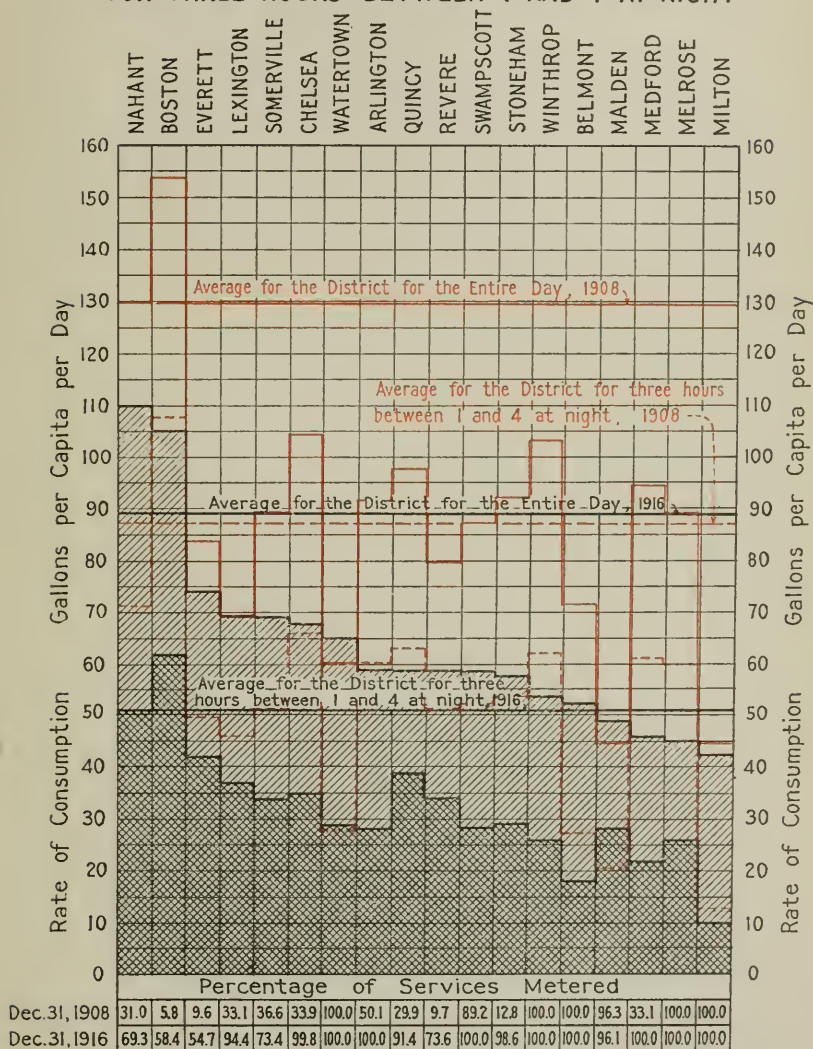
¹ Decrease.

The average consumption in the several districts was as follows: —

	Gallons per Day, 1916.	INCREASE FROM 1915.	
		Gallons per Day.	Percent- age.
Southern low-service district, embracing the low-service district of Boston, with the exception of Charlestown and East Boston, .	42,132,900	156,500	0.37
Northern low-service district, embracing the low-service districts of Somerville, Chelsea, Malden, Medford, Everett, Arlington, Charlestown and East Boston, .	21,338,400	1,909,700	9.83
Southern high-service district, embracing Quincy and Watertown, the high-service districts of Boston, and portions of Belmont and Milton, .	33,766,200	1,990,800	6.27
Northern high-service district, embracing Melrose, Revere, Winthrop, Swampscott, Nahant and Stoneham, and the high-service districts of Somerville, Chelsea, Malden, Medford, Everett and East Boston, .	7,643,600	245,400	3.32
Southern extra high-service district, embracing the higher portions of Hyde Park, Milton and West Roxbury, .	656,000	12,000 ¹	1.80 ¹
Northern extra high-service district, embracing Lexington and the higher portions of Arlington and Belmont, .	800,700	105,900	15.24
Totals,	106,337,800	4,396,300	4.31

¹ Decrease.

AVERAGE RATE OF CONSUMPTION OF WATER IN THE METROPOLITAN WATER DISTRICT FOR THE ENTIRE DAY AND FOR THREE HOURS BETWEEN 1 AND 4 AT NIGHT

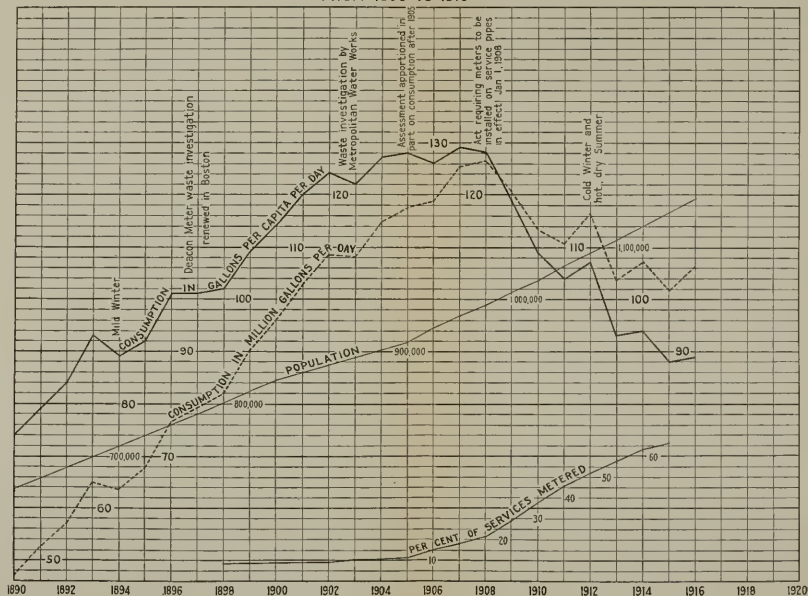


Average Rate of Consumption for Entire Day, 1916
 " " " " between 1 and 4 at night, 1916...
 Average Rate of Consumption for Entire Day, 1908
 " " " " between 1 and 4 at night, 1908

THE HISTORY OF THE CITY OF BOSTON

From its first settlement in 1630 to the present time. By SAMUEL JOHNSON, Esq. of the Middle Temple, Barrister at Law. In two Volumes. The first Volume contains the History from 1630 to 1780. The second Volume contains the History from 1780 to the present time. With a Plan of the City, and a Map of the Harbor. Boston: Printed and Sold by S. JOHNSON, at the Sign of the Anchor, in the City of Boston. 1780.

POPULATION, CONSUMPTION OF WATER AND PER CENT OF SERVICES METERED
 IN THE
 METROPOLITAN WATER DISTRICT
 AS SUPPLIED IN 1916
 FROM 1890 TO 1916



CITY OR TOWN.	Number of Meters required to be set on Old Services Each Year.	METERS SET ON OLD SERVICES.										NEW SERVICES.				Services in Use December 31, 1916.	Per Cent. of Services metered December 31, 1916.	
												INSTALLED.		EQUIPPED WITH METERS.				
		1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	Totals.	1908 to 1915, inclusive.	Totals.	1908 to 1915, inclusive.	1916. ¹	Totals.		
Boston.	4,276	84	5,503	5,481	6,487	6,022	5,600	5,897	5,418	5,802	46,294	13,731	1,675	15,406	10,865	1,287	12,152	104,615
Somerville.	411	732	621	501	570	488	508	422	439	434	4,715	1,723	200	1,923	1,792	268	2,060	13,418
Malden.	14	43	62	8	2	3	3	3	3	2	120	1,071	87	1,158	924	87	1,011	8,097
Chelsea.	240	198	756	779	1,092	132	33	6	3	2	3,001	930	156	1,086	903	156	1,059	5,125
Everett.	252	338	255	277	285	215	235	201	215	237	2,318	823	89	912	767	85	852	5,980
Quincy.	230	358	33	423	1,680	1,090	647	193	21	16	4,461	2,070	376	3,650	3,247	614	2,939	9,705
Medford.	179	857	927	1,555	178	6	7	4	—	1	3,585	1,870	376	2,248	1,826	392	2,218	6,409
Norfolk.	119	2,432	135	7	5	—	157	487	218	62	1,633	1,624	97	728	1,396	105	1,549	4,098
Revere.	138	85	184	110	176	154	157	487	218	62	1,633	1,624	166	1,770	1,396	150	1,549	4,098
Watertown.	55	108	56	63	127	261	349	—	—	—	964	917	166	1,063	1,016	343	1,181	4,536
Arlington.	—	—	—	—	—	—	—	—	—	—	—	987	211	1,198	1,016	209	1,225	2,947
Milton.	—	—	—	—	—	—	—	—	—	—	—	624	104	728	624	104	728	1,965
Winthrop.	100	213	975	706	6	—	—	8	4	—	1,912 ²	810	70	880	847	70	917	2,970
Stoneham.	65	116	225	186	155	252	189	100	78	1	1,302	272	21	293	274	21	295	1,634
Belmont.	—	—	—	—	—	—	—	—	—	—	—	718	202 ³	920	715	202 ³	917	1,632
Lexington.	32	113	70	56	86	95	4	48	67	19	558	464	53	517	433	59	492	1,206
Nahant.	16	30	40	26	18	17	4	15	53	32	235	245	16	261	210	16	226	745
Swampscott.	21	264	142	28	13	—	—	—	—	—	447	539	68	607	539	68	607	1,873
Totals.	6,148	5,971	9,984	10,206	10,880	8,732	7,735	7,444	6,528	6,607	74,087	31,226	4,140	35,366	27,103	4,238	31,341	179,919
																		127,407
																		70.81

¹ The number of new meters installed and the number of new services equipped with meters seldom agree for the reason that service pipes are installed but meters are not set until the buildings are permanently occupied.

² Includes 179 not reported Dec. 31, 1915.

³ Includes 36 not reported Dec. 31, 1915.

Installation of Meters on Service Pipes.

Information regarding the installation of meters on service pipes to December 31, 1916, by the municipalities supplied with water from the Metropolitan Water Works is given in the table on page 101.

Chapter 524 of the Acts of the year 1907 requires that in these municipalities meters shall be set each year on all new service pipes and on 5 per cent. of all service pipes that were without meters on December 31, 1907. All of the municipalities have complied with the provision that meters shall be set on 5 per cent. of the service pipes that were without meters on December 31, 1907, and in 11 cases the number of meters set on old service pipes materially exceeds the requirement of the statute. In regard to the installation of meters on new service pipes, the provision of the statute has not been strictly complied with by several of the municipalities. This is partly accounted for by the fact that new service pipes are frequently installed when building operations are begun and the meters are not set until the buildings are permanently occupied. As the total number of meters set on both old and new service pipes in each of the municipalities is equal to or exceeds the total number of meters required by the statute to be set to December 31, 1916, it would seem that although the provisions of the statute have not been carried out exactly as specified the purpose of the law has been accomplished.

During the year 4140 service pipes and 10,845 meters were installed in the 18 municipalities supplied from the Metropolitan Water Works and at the close of the year 179,919 service pipes and 127,407 meters were in use; 70.81 per cent. of all the service pipes had been provided with meters and in 8 of the municipalities all of the service pipes were equipped with meters.

WATER SUPPLIED OUTSIDE OF METROPOLITAN WATER DISTRICT.

During the year 411,686,000 gallons of water were supplied from the Metropolitan Water Works for use outside of the Metropolitan Water District as follows:—

PLACES SUPPLIED.	Total Quantity (Gallons).	Average Quantity (Gallons per Day). ¹	Number of Days on which Water was supplied.	Amounts charged for Water supplied.
Westborough State Hospital,	62,972,000	172,000	366	\$1,989 16
Town of Framingham: —				
From Sudbury Aqueduct,	86,100,000	235,246	339	} 2,506 86
From Filter-gallery at Farm Pond,	230,300,000	629,235	366	
United States Government: —				
Peddock's Island,	25,202,000	69,100	366	1,585 99
Town of Saugus,	7,022,000	19,200	366	400 00

¹ For the entire year.

QUALITY OF THE WATER.

The yearly average results of the chemical analyses made by the State Department of Health, and of the biological and bacteriological examinations, made in the Metropolitan Water Works laboratory, of water from service taps in Boston since 1898 are given in tables on pages 187 to 190.

ENGINEERING.

In connection with the maintenance of the works the engineering force has made plans, estimates and reports for various projects and improvements; has made record plans of water works lands and structures, surveys and plans of sanitary conditions at premises on the watersheds and for land purchases and takings; has tested meters; made photographs, blueprints and analyses of coal and oil; calculated yields of watersheds; made current meter gagings; kept hydraulic and meteorological records; summarized power station and pumping station records; cared for the recording pressure gages and supervised various operations carried on by the department.

Appended to this report are tables giving additional information relating to the operations of the Metropolitan Water Works for the year 1916 and the usual water works statistics.

Respectfully submitted,

WILLIAM E. FOSS,
Chief Engineer.

BOSTON, January 1, 1917.

REPORT OF CHIEF ENGINEER OF SEWERAGE WORKS.

To the Metropolitan Water and Sewerage Board.

GENTLEMEN:—The following report of the operations of the Metropolitan Sewerage Works for the year ending December 31, 1916, is respectfully submitted:—

ORGANIZATION.

The Chief Engineer has charge of the design and construction of all new works, and of the maintenance and operation of all the works controlled by the Metropolitan Water and Sewerage Board for removing sewage from the twenty-six municipalities which comprise the Metropolitan Sewerage Districts.

The following assistants have been employed during the year:—

Henry T. Stiff,	. . . . .	Division Engineer, in charge of office and drafting room and of the construction work.
Clarence A. Moore,	. . . . .	Assistant Engineer, in charge of maintenance studies and records and of construction work on the North Metropolitan System.
Arthur F. F. Haskell,	. . . . .	Assistant Engineer, in charge of survey work and field work in connection with the Wellesley extension construction.
Ralph W. Loud,	. . . . .	Assistant Engineer, in charge of survey work and field work in connection with the Reading extension construction.
George W. Wood,	. . . . .	Assistant Engineer, on Malden River siphon and Deer Island extension.

In addition to the above, the number of engineering and other assistants employed during the year was 23, which includes 3 instrumentmen, 10 inspectors, 2 draftsmen, 6 rodmen and engineering assistants and 2 stenographers.

METROPOLITAN SEWERAGE DISTRICTS.

AREAS AND POPULATIONS.

During the year the town of Reading has been admitted to the North Metropolitan Sewerage District, as provided in Chapter 159 of the General Acts of 1916.

The populations of the districts, as given in the following table, are based on the census of 1915.

Table showing Ultimate Contributing Areas and Present Estimated Populations within the Metropolitan Sewerage Districts, as of December 31, 1916.

CITY OR TOWN.		Area (Square Miles).	Estimated Population.
North Metropolitan District.	Arlington,	5.20	15,980
	Belmont,	4.66	8,750
	Boston (portions of),	3.45	108,310
	Cambridge,	6.11	110,770
	Chelsea,	2.24	45,660
	Everett,	3.34	39,330
	Lexington, ¹	5.11	4,080
	Malden,	5.07	50,660
	Medford,	8.35	32,710
	Melrose,	3.73	17,410
	Reading,	9.82	7,160
	Revere,	5.86	27,430
	Somerville,	3.96	90,120
	Stoneham,	5.50	7,630
	Wakefield,	7.65	13,240
South Metropolitan District.	Winchester,	5.95	10,390
	Winthrop,	1.61	13,750
	Woburn,	12.71	16,690
		100.32	620,070
	Boston (portions of),	24.96	257,550
	Brookline,	6.81	35,280
	Dedham, ¹	9.40	11,490
	Milton,	12.59	8,950
	Newton,	16.88	44,300
	Quincy,	12.56	42,570
	Waltham,	13.63	31,050
	Watertown,	4.04	17,590
	Wellesley,	9.89	6,850
		110.76	455,630
Totals,		211.08	1,075,700

¹ Part of town.

METROPOLITAN SEWERS.

SEWERS PURCHASED AND CONSTRUCTED AND THEIR CONNECTIONS.

During the year there have been built 2.654 miles of Metropolitan sewer within the sewerage districts, so that there are now 111.484 miles of Metropolitan sewers. Of this total, 9.642 miles of sewers, with the Quincy pumping station, have been purchased from cities and towns of the districts, the remaining 101.842 miles of sewers and other works having been constructed by the Metropolitan boards.

The locations, lengths and sizes of these sewers are given in the following tables, together with other data referring to the public and special connections with the systems:—

NORTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1916.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston:—					
Deer Island, .	4' 0" to 9' 0", . . .	1.613	4	—	—
East Boston, .	9' 0" to 1' 0", . . .	5.467	25	Shoe factory,	1
				Middlebrook Wool-combing Co.,	8
Charlestown, .	6' 7"×7' 5" to 1' 0", . . .	3.292	14	Navy Yard,	1
				Almshouse,	1
Winthrop, . .	9' 0",	2.864	13	Private building,	1
				Club house,	1
				Fire Department Station,	1
				Private building,	1
				Bakery,	1
				Rendering works,	1
Chelsea, . . .	8' 4"×9' 2" to 15", . . .	5.230	13	Metropolitan Water Works blow-off,	1
				Chelsea Water Works blow-off,	2
				Metropolitan Water Works blow-off,	1
				Cameron Appliance Co.,	1
Everett, . . .	8' 2"×8' 10" to 4' 8"×5' 1", . . .	2.925	7	Shultz-Goodwin Co.,	1
				Andrews-Wasgatt Co.,	1
				National Metallic Bed Co.,	1
				Linoide Co.,	1
				Factory,	1
Lexington, ¹ . .	—	—	1	New England Structural Co.,	1
Malden, . . .	4' 6"×4' 10" to 1' 0", . . .	5.844 ²	33	Metropolitan Water Works blow-off,	1
				Private buildings,	178

¹ Lexington, although admitted to the Metropolitan Sewerage System in 1897, has not contributed sewage to the Metropolitan trunk lines until the present year as no local sewerage system had been constructed. Connection was made with the Metropolitan sewers September 11, 1916.

² Includes 1.84 miles of sewer purchased from the city of Malden.

NORTH METROPOLITAN SEWERAGE SYSTEM—*Concluded.*

Location, Length and Sizes of Sewers, with Public and Special Connections
— Concluded.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1916.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Melrose, . . .	4' 6" X 4' 10" to 10", . . .	6.099 ¹	38	Private buildings, . . .	114
				Factory, . . .	1
				Railroad station, . . .	1
				Park Department bath house, . . .	1
				Harvard dormitories, . . .	2
Cambridge, . . .	5' 2" X 5' 9" to 1' 3", . . .	7.209	44	Slaughterhouse, . . .	1
				City Hospital, . . .	3
				Street railway machine shop, . . .	1
				Private buildings, . . .	1
				Tannery, . . .	1
				Slaughterhouses (3), . . .	1
				Car-house, . . .	1
Somerville, . . .	6' 5" X 7' 2" to 10", . . .	3.577	11	Somerville Water Works blow-off, . . .	1
				Street railway power-house, . . .	1
				Stable, . . .	1
				Rendering works, . . .	1
				Railroad scale pit, . . .	1
				Armory building, . . .	1
Medford, . . .	4' 8" X 5' 1" to 10", . . .	5.713	24	Private buildings, . . .	9
				Stable, . . .	1
				Police substation, . . .	1
				Tannery, . . .	5
				Private buildings, . . .	7
				Gelatine factory, . . .	1
Winchester, . . .	4' 6" to 1' 3", . . .	9.470	22	Watch-band factory, . . .	1
				Stable, . . .	1
				Railroad station, . . .	1
				Felt works, . . .	1
				Town Hall, . . .	1
Stoneham, . . .	1' 3" to 10", . . .	0.010	4	- . . .	-
Woburn, . . .	1' 10" X 2' 4" to 1' 3", . . .	0.933	3	Glue factory, . . .	1
				Private buildings, . . .	152
Arlington, . . .	1' 6" to 10", . . .	3.520 ²	42	Railroad station, . . .	1
				Car-house, . . .	3
				Post office, . . .	1
Belmont, ³ . . .	- . . .	-	3	- . . .	-
Wakefield, ³ . . .	- . . .	-	1	- . . .	-
Revere, . . .	4' 0" to 15", . . .	0.136	3	- . . .	-
		63.902 ⁴	305		528

¹ Includes .736 of a mile of sewer purchased from the city of Melrose.

² Includes 2,631 miles of sewer purchased from the town of Arlington.

³ The Metropolitan sewer extends but a few feet into the towns of Belmont and Wakefield.

⁴ Includes 2.787 miles of Mystic Valley sewer in Medford, Winchester and Woburn, running parallel with the Metropolitan sewer.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Location, Length and Sizes of Sewers, with Public and Special Connections.

CITY OR TOWN.	Size of Sewers.	Length in Miles.	Public Connections, December 31, 1916.	SPECIAL CONNECTIONS.	
				Character or Location of Connection.	Number in Operation.
Boston: —				Tufts Medical School, . . .	1
Back Bay, . . .	6' 6" to 3' 9", . . .	1.500 ¹	16	Private house, . . .	1
				Administration Building, . . .	1
				Boston Park Department, . . .	1
				Simmons College buildings, . . .	1
				Art Museum, . . .	2
Brighton, . . .	5' 9"×6' 0" to 12", . . .	6.010 ²	15	Abattoir, . . .	3
				Chocolate works, . . .	2
				Machine shop, . . .	1
Dorchester, . . .	3'×4' to 2' 6"×2' 7", . . .	2.870 ³	13	Paper mill, . . .	1
				Private buildings, . . .	3
				Edison Electric Company Station, . . .	1
Hyde Park, . . .	10' 7"×11' 7" to 4' 0"×4' 1", . . .	4.527	18	Mattapan Paper Mills, . . .	1
				Private buildings, . . .	2
Roxbury, . . .	6' 6"×7' to 4' 0", . . .	1.430	—	Fairview Cemetery buildings, . . .	1
West Roxbury, . . .	9' 3"×10' 2" to 12", . . .	7.600	16	Parental School, . . .	1
				Lutheran Evangelical Church, . . .	1
Brookline, . . .	6' 6"×7' 0" to 8", . . .	2.540 ⁴	12	Private buildings, . . .	4
Dedham, . . .	4'×4' 1" to 3' 0"×3' 4", . . .	2.368	7	Private building, . . .	2
Hull, ⁵ . . .	60" pipe, . . .	0.750	—	— . . .	—
Milton, . . .	11'×12' to 8", . . .	3.600	23	Private buildings, . . .	2
Newton, . . .	4' 2"×4' 9" to 1' 3", . . .	2.911	7	Private houses, . . .	6
Quincy, . . .	11' 3"×12' 6" to 24" pipe, . . .	6.845	14	Metropolitan Water Works blow-off, . . .	1
Waltham, . . .	3' 6"×4' 0", . . .	0.001	1	— . . .	—
Watertown, . . .	4' 2"×4' 9" to 12", . . .	0.750 ⁶	5	Factories, . . .	2
				Stanley Motor Carriage Co., . . .	1
Needham, ⁵ . . .	2' 0"×2' 3" to 2' 3"×2' 6", . . .	3.880	—	Knights of Pythias building, . . .	1
Wellesley, ⁷ . . .	— . . .	—	—	— . . .	—
		47.582	147		42

¹ Includes .355 of a mile of sewer purchased from the city of Boston.² Includes .446 of a mile of pipe and concrete sewers built for the use of the city of Boston; also .026 of a mile of sewer purchased from the town of Watertown.³ Includes 1.24 miles of sewer purchased from the city of Boston.⁴ Includes .153 of a mile of pipe sewer built for the use of the town of Brookline.⁵ Hull and Needham are not parts of the Metropolitan Sewerage District.⁶ Includes .025 of a mile of sewer purchased from the town of Watertown.⁷ The Metropolitan sewer extends but a few feet into the town of Wellesley.

Information relating to areas, populations, local sewer connections and other data for the Metropolitan Sewerage districts appears in the following table:—

North Metropolitan Sewerage District.

Area (Square Miles).	Estimated Total Population.	Miles of Local Sewer connected.	Estimated Population contributing Sewage.	Ratio of Contributing Population to Total Population (Per Cent.).	CONNECTIONS MADE WITH METRO- POLITAN SEWERS.	
					Public.	Special.
100.32	620,070	761.76	557,160	89.9	305	528

South Metropolitan Sewerage District.

110.76	455,630	641.31	317,005	69.6	147	42
--------	---------	--------	---------	------	-----	----

Both Metropolitan Sewerage Districts.

211.08	1,075,700	1,403.07	874,165	81.3	452	570
--------	-----------	----------	---------	------	-----	-----

Of the estimated gross population of 1,075,700 on December 31, 1916, 874,165, representing 81.3 per cent., were on that date contributing sewage to the Metropolitan sewers, through a total length of 1,403.07 miles of local sewers owned by the individual cities and towns of the districts.

These sewers are connected with the Metropolitan systems by 452 public and 570 special connections. During the current year there has been an increase of 32.11 miles of local sewers connected with the Metropolitan systems, and 13 public and 12 special connections have been added.

CONSTRUCTION.**NORTH METROPOLITAN SEWERAGE SYSTEM.****DEER ISLAND OUTFALL EXTENSION.**

Section 1A, the temporary 60-inch cast-iron outfall to be used in connection with the outfall extension, has been completed. The particulars of this contract were given in last year's report. This work was finished and the sewage turned through it on October 16, 1916. No particular difficulties were encountered in the work excepting delays from stormy weather.

SECTION 1. — DEER ISLAND OUTFALL EXTENSION.

A contract for laying the 84-inch cast-iron pipe and specials for the extension of the outfall sewer near Deer Island Light was made early in the year. Some particulars of this section and contract are as follows:

Date of contract No. 135, April 22, 1916.

Length of section, 322 feet.

Name of contractor, Roy H. Beattie, Incorporated.

Depth of work below mean high water, 70 feet.

Diameter of cast-iron pipe, 84 inches to 48 inches.

Assistant Engineer in charge of construction, Clarence A. Moore.

This work consists of dredging a channel and placing the pipe in the same and backfilling. Part of the pipe rests on a stone foundation pier which extends from Station 2+58 to Station 3+22. This portion will be protected by stone riprap. The remainder of the pipe will be placed on sills supported by piles or blocking. Work was begun on July 9, 1916, and dredging was practically completed August 25, 1916. Considerable time was lost in this work because of the stormy weather which rendered it impossible to work in this exposed location.

The work of placing the stone foundation was begun September 23, 1916, and has been completed. Operations were begun at the southerly end and the cast-iron pipe has been laid toward the existing outfall between Stations 3+18 and 2+10. The riprap reinforcement has been completed over this section. Owing to the swift current at this place work could be carried on only at the slack periods at the turn of the tide. Work was suspended for the season on December 13, 1916, because of weather conditions. It is expected that the contract will be completed early in the coming year. No unexpected difficulties have been encountered.

SECTION 19. — MALDEN RIVER SIPHON.

The work on this section and the contract are described in last year's report. The work was completed without difficulty and the siphon was put in operation May 9, 1916.

REMOVAL OF OLD MALDEN RIVER SIPHON.

In accordance with the Acts of Congress, Chapter 253 of 1912 and Chapter 142 of 1915 which carried appropriations for improvements in Malden River, it was necessary that the Commonwealth should remove the old Malden River sewerage siphon. This was provided for in Chapter 215 of the General Acts of the Legislature of the year 1915. A contract for this work was made, some particulars of which are as follows:

Date of contract No. 137, June 30, 1916.

Name of contractor, Boston Dredging Company.

Depth of work below mean high water, 35 feet.

Assistant Engineer in charge of construction, Clarence A. Moore.

Work was started under this contract July 29, 1916, and was completed September 22, 1916. It was found impracticable to pull the piles in the deep sections and they were cut off at an elevation of 25 feet below mean low water and the portion remaining below this elevation was left in place.

In connection with this work a cast-iron sluice gate has been placed at the Wellington end of the old siphon. It is the intention to use this westerly portion of the old siphon extending from the Wellington side head house to the proposed channel as an overflow and emergency outlet. The duties imposed upon the Commonwealth by the terms of the Acts of Congress have been completed and as far as our work is concerned the channel improvements at Malden River can be made.

EXTENSION TO READING.

Chapter 159 of the General Acts of 1916 provided for the admission of the town of Reading into the North Metropolitan Sewerage District and also for the construction through Wakefield, Reading and Stoneham of a trunk sewer connecting Reading with the existing North Metropolitan trunk sewer in Woburn. This Act was accepted by the town of Reading on May 22, 1916. Studies and surveys have been made and a part of the line has been located extending from the town line of Reading at a point in Brook Street, southerly in Wakefield through lands of Lucia Beebe and Edward F. Gilman, then across Summer Avenue and then in Reading through land of George A. Forbes, then in

Wakefield still through land of George A. Forbes and land of Herbert M. Hopkins, across Hopkins Street then through lands of Herbert M. Hopkins and Joseph E. Hopkins, across North Street, and then in Stoneham through lands of Bear Hill Associates, Inc., lands of Everel K. Farr, Walter Steele and Nathaniel F. Fletcher, across Main Street and through lands of J. Arthur Wessel, Richard C. Christie, Ellen Magner, Annie E. Greene, Margaret McLaughlin and Elizabeth L. McGrady to a point in land of Mary A. Scally. This portion of the work, about 7,500 feet, will be constructed in rock tunnel, excepting 1,370 feet near the Reading town line, and will consist of a concrete sewer 24" x 27" in trench and a concrete sewer in tunnel 36 inches in diameter. This part of the line will be known as Sections 76 and 75.

A contract and specifications were prepared for Section 76 and bids were asked for, the opening date being November 27, 1916. No bids were received. Plans and specifications for Section 75 are now being made.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

WELLESLEY EXTENSION.

During the year surveys have been completed over the remaining part of the line and Sections 98, 99 and 102 have been advertised for construction.

SECTION 98. — WELLESLEY EXTENSION.

This section begins at Station 22+25 of Section 26 of the Neponset Valley sewer in West Roxbury and extends southwesterly through land of Mary A. Read, crossing Charles River into Dedham and extending through land of Hannah Bingham and land of Catherine H. Rooney, other land of Hannah Bingham and then crosses Bridge Street and passes along Bullard Road, turning into Hillcrest Avenue and extending into Violet Avenue, a total distance of 3,350 feet.

A contract was made for the construction of this section, some particulars of which are as follows:

Date of contract No. 138, July 13, 1916.

Name of contractor, Thomas Russo & Company.

Length of section, 3,350 feet.

Average depth of cut, 15 feet.

Dimensions of concrete sewers, 36 inches by 40 inches, and 34 inches by 37 inches.

Assistant Engineer in charge of construction, Arthur F. F. Haskell.

Work was started under this contract July 31, 1916, at Station 19+89. The Contractor encountered considerable difficulty because of fine sand and finally abandoned the contract, having constructed but 30 feet of concrete invert.

The Metropolitan Water and Sewerage Board entered into a contract with George M. Bryne, dated October 23, 1916, for the completion of this section. Work was started under the latter contract November 5, 1916, and at the date of this report there have been constructed 93 feet of sewer and the trench has been partially excavated for a distance of 137 feet. Progress on this section has been slow owing to the nature of the ground. Much valuable time has been lost as the section for about 1,700 feet extends across the marsh through which the Charles River runs. At certain periods of the year the river overflows this marsh and work on this portion can be done only in the dry season. It was the intention to have this part of the work completed during the autumn months.

SECTION 99. — WELLESLEY EXTENSION.

This section extends from a point in Violet Avenue, westerly along said avenue and enters land of Edward and Catherine Bingham, then crosses Pine Street and extends along Jenney Lane, then passes through land of Lawrence Minot, *et al.*, Trustees, and crosses the Charles River to a point in land of Stephen M. Weld. Contract No. 139 for this section was advertised and bids were received on June 30, 1916. All bids were rejected and no contract for the construction of this section has been made.

SECTIONS 100 AND 101. — WELLESLEY EXTENSION.

Survey work has been completed for Sections 100 and 101 and maps are being made.

SECTION 102. — WELLESLEY EXTENSION.

This section starts from a point in Needham in the land of Mrs. Mary J. Sidney and extends northerly through said land and land of John T. Morse, Jr., then through land of Charles P. Beebe, then through land of Richard G. Wadsworth, land of Hannah E. Pond and land of J. Austin Amory to a point in Chestnut Street. Bids for the construction of this section were opened on September 27, 1916, and a contract was made, some particulars of which are as follows:

Date of contract No. 143, October 2, 1916.

Name of contractor, Bruno & Petitti.

Length of section, 6,851 feet.

Average depth of cut, 9 feet.

Dimensions of concrete sewer, 27 inches by 30 inches.

Assistant Engineer in charge of construction, Arthur F. F. Haskell.

Work on this section was begun at two places, one on October 7, 1916, at Station 0 and the other on November 5, 1916, near Station 50+42. From Station 0 to Station 3+12 and from Station 5+10 to Station 8+00 it was found necessary to excavate below grade because of the presence of peat. This was refilled to grade with special concrete. About 1,250 feet have been constructed in the opening near Station 0 and 240 feet in the opening near Station 50+42. A very small amount of ground water has been encountered. Ledge was found at various points between Station 9+50 and Station 13+48.

SECTION 103. — WELLESLEY EXTENSION.

The particulars of this section and contract were described in last year's report. Openings were started on this section near Station 0 and near Station 36+40 early in April. No particular difficulty has been encountered in the work. From Station 6+15 to Station 12+15 it was necessary to introduce a pile foundation. Work was completed on this section early in December.

SECTION 104. — WELLESLEY EXTENSION.

The particulars of this contract were described in last year's report. Work was started on the section in tunnel near Station 17+72. No special difficulties have been encountered in the work. At the date of this report the work in tunnel has been completed excepting manhole at Station 27+20. The work in open cut has been completed excepting a manhole at Station 3+28. A considerable amount of rock was encountered in all parts of the work. The sewer from Station 30+30 to the end of the section was constructed almost wholly in rock trench.

The contractors on these sections have experienced considerable difficulty in obtaining labor owing to the general scarcity of the same and the remoteness of this location.

It has not been possible to let contracts for Sections 99, 100 and 101 during this year because of the insufficiency of the appropriation for the construction of this work. The amount appropriated by Act 343 of the year 1914 was \$350,000. This estimate was made by the State Board of Health in 1913. The European war which started after this appropriation was made has so increased the cost of labor and materials that the original appropriation probably will complete about one half the line.

MAINTENANCE.

SCOPE OF WORK AND FORCE EMPLOYED.

The maintenance of the Metropolitan Sewerage System includes the operation of 7 pumping stations, the Nut Island screen-house and 111.484 miles of Metropolitan sewers, receiving the discharge from 1,403.07 miles of town and city sewers at 452 points, together with the care and study of inverted siphons under streams and in the harbor.

The permanent maintenance force includes 163 men, of whom 100 are employed on the North System and 63 on the South System. These are subdivided as follows: North Metropolitan System, 58 engineers and other employees at the pumping stations; on maintenance, care of sewer lines, buildings and grounds, 42 men, including foremen; South Metropolitan System, 35 engineers and other

employees within the pumping stations; and 28 men, including foremen, on maintenance, care of sewer lines, buildings and grounds.

The regular work of this department, in addition to the operation of the pumping stations, has consisted of the routine work of cleaning and inspecting sewers and siphons, caring for tide gates, regulators and overflows, measuring flow in sewers, inspection of connections to the Metropolitan sewers, care of pumping stations and other buildings and grounds, and the maintenance of the ferry at Shirley Gut for transporting employees and supplies in connection with the operation of the Deer Island pumping station.

In addition to these regular duties other work has been done by this department as follows:

DEER ISLAND PUMPING STATION.

During the year, at this station, the interior of the engine room and boiler room has been cleaned and newly painted. A new work scow of 20 tons capacity for transporting materials and other harbor use has been constructed.

All work was done by maintenance employees.

EAST BOSTON PUMPING STATION.

A one-story masonry building 13 feet by 30 feet with a concrete roof has been constructed in the stock yard on Addison Street to be used as a stock and pattern building.

All work was done by maintenance employees.

WARD STREET PUMPING STATION.

At this station are four 175 horse power upright boilers of the Dean type, which were put in operation in 1904. During the last two years much trouble has been caused by the breaking of stay bolts and this condition had become so serious that it was finally decided to re-stay completely all of these boilers. The labor for this work was done by contract with the Atlantic Works of Boston. The stay bolts were furnished by the Metropolitan Water and Sewerage Board and consisted of Burden iron. These boilers are now in good condition.

The pumping plant at this station has been in service since 1904 and is in good condition. It furnishes a complete duplication of units for ordinary flows. In time of storm, however, it is necessary

to run both of the pumping engines. So far, all the necessary repairs on the plant have been accomplished in such a manner as to leave always the two engines ready for use at short notice. It is probable, however, that at some time more extensive repairs will have to be made and that it will be necessary to have one pump temporarily out of service. This would leave a deficiency in the pumping plant in time of storm. To guard against such a condition, Chapter 93 of the General Acts of 1916 provided that additional boilers and pumping plant should be installed at this station. A contract for the installation of the boilers was entered into, some particulars of which are as follows:

Date of contract No. 136, May 20, 1916.

Name of contractor, D. M. Dillon Steam Boiler Works.

Articles contracted for, two 175 horse power vertical boilers.

The boilers are nearly completed and will be delivered early in the coming year.

Contract and specifications were prepared for a 50,000,000 gallon steam-turbine driven pumping unit and bids were solicited. These were opened on October 11, 1916. All bids, being in excess of the amount appropriated, were rejected.

NUT ISLAND SCREEN-HOUSE.

The dwelling house owned by the Commonwealth and occupied by the Engineer in charge at the Nut Island screen-house has received extensive repairs. These consist of masonry foundation, shingling the vertical walls of the house and the construction of a new piazza.

All work was done by maintenance employees.

GASOLINE IN PUBLIC SEWERS.

The effort to improve the condition of the Metropolitan sewers in regard to dangers from gasoline explosion has been successful. An inspector has been employed in this department whose duties are to visit existing garages and see that the separators are kept in proper condition, also to enforce the regulation concerning the installation of such separators at all newly constructed garages. While the presence of gasoline in the sewers is noted occasionally, the condition has been greatly improved.

TABLE SHOWING NUMBER OF PLACES CONNECTED WITH PUBLIC SEWERS WHERE GASOLINE IS USED AND PROGRESS OF WORK OF INSTALLING SEPARATORS TO JANUARY 1, 1917.

North Metropolitan Sewerage District.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1916.	Number of Places where Changes have yet to be made.	Remarks.
Arlington,	3	-	3	1	-	Town sewerage system put in operation this year.
Belmont,	3	-	1	1	1	
Boston: —						
Charlestown District, . .	11	-	7	4	-	
East Boston District, . .	7	-	7	-	-	
Cambridge,	50	-	40	9	1	
Chelsea,	9	-	9	-	-	
Everett,	13	-	12	1	-	
Lexington,	-	-	-	-	-	
Malden,	19	-	18	1	-	
Medford,	10	-	10	-	-	
Melrose,	5	-	4	1	-	
Revere,	6	-	5	1	-	
Somerville,	31	8	26	4	1	
Stoneham,	3	-	2	1	-	
Wakefield,	4	-	4	-	-	
Winchester,	12	-	6	6	-	
Winthrop,	4	-	3	1	-	
Woburn,	2	-	2	-	-	
Reading,	-	-	-	-	-	
Totals,	192	8	159	31	3	Not yet connected with Metropolitan sewers.

TABLE SHOWING NUMBER OF PLACES CONNECTED WITH PUBLIC SEWERS WHERE GASOLINE IS USED AND PROGRESS OF WORK OF INSTALLING SEPARATORS TO JANUARY 1, 1917.

South Metropolitan Sewerage District.

CITY OR TOWN.	Number of Places connected with Sewer.	Number of Places originally having Acceptable Separators.	Number of Places where Changes have been made.	Number of New Garages built, 1916.	Number of Places where Changes have yet to be made.	Remarks.
Boston: —						
Hyde Park District, .	8	-	4	1	3	Not yet fully reported upon.
West Roxbury District, .	51	5	26	10	10	Not yet fully reported upon.
Back Bay District, .						
Brighton District, .						
Dorchester District, .						
Brookline,	55	9	36	10	-	
Dedham,	2	2	-	-	-	
Milton,	-	-	-	-	-	No garages connected with the public sewers.
Newton,	31	18	5	8	-	
Quincy,	12	-	9	2	1	
Waltham,	3	3	-	3	-	In most cases garages are connected with the surface drains.
Watertown,	13	3	8	2	-	
Wellesley,	-	-	-	-	-	No connection as yet with Metropolitan sewers.
Totals,	175	40	88	36	14	

DRAINAGE FROM TANNERIES, GELATINE AND GLUE WORKS IN WINCHESTER, WOBURN AND STONEHAM.

Four men and a foreman have been employed during a part of the year in flushing and cleaning the Metropolitan sewers through the tannery districts of Winchester, Woburn and Stoneham.

All the tanneries and glue works of the district now have settling tanks of substantial size. This method of treatment has very greatly reduced the amount of sludge material entering the Metropolitan sewers.

The following table gives details of settling tanks introduced to date, showing the operations of same with the amount of sludge collected and removed:—

Table of Semi-fluid Sludge removed from Settling Basins at the Tanneries, Gelatine and Glue Works in Winchester, Woburn and Stoneham, Year ending December 31, 1916.

LOCATION OF BASIN.	Basin put in Operation.	Inside Measurement of Basin (Feet).	Number of Times cleaned during the Year.	Average Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).	Total Quantity Semi-fluid Sludge removed during the Year (Cubic Yards).
Beggs & Cobb Company, Basin No. 1, .	Jan. 15, 1910	47.0 × 23.0	6	136.00	816.00
Beggs & Cobb Company, Basin No. 2, .	May 9, 1910	47.0 × 23.0	5½	136.00	748.00
Beggs & Cobb Company, Basin No. 3, .	Oct. 19, 1911	51.0 × 25.0	6	162.50	975.00
S. C. Parker & Son,	Aug. 1, 1910	48.3 × 23.0	½	69.88	34.94
American Hide and Leather Company, Factory D.	Nov. 15, 1910	48.0 × 23.1	5	139.54	697.50
B. F. Kimball & Co.,	Dec. 10, 1910	47.2 × 23.0	5	106.84	534.20
E. Cummings Leather Company, . .	Nov. 1, 1910	45.9 × 22.6	1½	97.60	146.40
W. P. Fox & Sons,	July 12, 1910	47.8 × 22.6	7	135.20	946.40
Thayer & Foss,	Sept. 15, 1910	48.1 × 23.1	4½	104.86	471.87
Morris Kaplan, ¹	Jan. 9, 1911	46.8 × 22.9	—	—	—
Van Tassell Leather Company, . . .	May 1, 1911 {	10.2 × 14.5	2	3.00	6.00
		43.8 × 19.5	3	102.00	306.00
American Glue Company,	Oct. 1, 1910	47.1 × 23.0	1½	136.36	204.54
J. O. Whitten Company,	1902 {	35.5 × 24.7	17	58.74	998.60
		67.2 × 12.0	—	—	51.00
Total,	—	—	—	—	6,308.70

¹ Successors to Bay State Leather Company.

NORTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
Boston (Deer Island),	0.70	Separate,	—	—	975 ²	975 ²	Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Winthrop,	32.37	Separate,	2,974	4.55	13,530	13,750	1.40	1.61	100.0	87.0
Boston (East Boston),	33.54	Separate and combined,	3,055	12.70	64,200	67,335	1.17	2.18	98.4	53.7
Chelsea,	30.85	Separate and combined,	4,178	10.50	43,870	45,660	1.14	2.24	95.3	57.9
Everett,	47.42	Separate and combined,	5,055	6.90	34,880	39,330	1.97	3.34	96.1	59.0
Malden,	65.02	Separate,	6,889	6.00	45,465	50,660	3.10	5.07	88.7	59.0
Melrose,	38.56	Separate,	3,297	4.50	14,855	17,410	1.85	3.73	89.7	61.1
Boston (Charlestown),	21.22	Separate and combined,	5,411	7.35	39,770	40,000	0.67	1.27	85.2	49.6
Cambridge,	154.10	Separate and combined,	16,076	6.60	110,000	110,770	5.04	6.11	99.4	52.8
Somerville,	100.82	Separate and combined,	15,834	5.60	88,670	90,120	3.46	3.96	99.4	82.5
Medford,	64.37	Separate,	5,904	5.40	31,880	32,710	3.15	3.36	98.4	87.4
Worcester,	30.85	Separate,	1,872	5.20	9,735	10,390	1.47	5.95	97.5	37.7
Woburn,	15.32 ³	Separate,	1,220	5.80	7,075	16,690	1.00	12.71	93.7	24.7
Stonham,	13.46	Separate,	925	4.80	4,440	7,680	0.70	5.50	42.4	7.9
Arlington,	31.02	Separate,	2,204	5.90	13,005	15,980	1.93	5.20	58.2	12.7
Belmont,	21.05	Separate,	1,174	6.10	7,685 ⁴	8,750	1.31	4.66	81.4	37.1
Wakfield,	14.36	Separate,	1,775	5.50	4,260	13,240	0.60	8.75	28.1	28.1
Lexington,	6.51	Separate,	41	4.30	1,755	4,080	0.23	5.11	32.2	7.8
Revere, ⁵	40.22	Separate,	3,432	6.60	22,650	27,430	2.01	5.86	4.3	4.5
Reading, ⁵	—	—	—	—	—	7,160	—	9.82	82.6	34.3
Totals,	761.76	—	82,910	6.70	557,160	620,070	32.20	100.32	89.9	32.1

¹ Estimated from assessors' statement of the number of houses in each city or town ⁴ Including 2 connections with McLean Hospital, having an estimated population of 522.

on April, 1, 1916, and the population from census of 1915.

² Estimated by Supt. James H. Burke of the institution on Deer Island.

³ Exclusive of Mystic valley sewer and tanneries.

⁵ Reading not connected.

SOUTH METROPOLITAN SEWERAGE SYSTEM.

Table showing Cities and Towns delivering Sewage to this System; Approximate Miles of Sewers connected; Estimated Populations and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; Ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1916.]

CITIES AND TOWNS.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection. ¹	Estimated Population now contributing Sewage.	Estimated Present Population.	Estimated Area now contributing Sewage.	Area ultimately to contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
							Sq. Miles.	Sq. Miles.	Per Cent.	Per Cent.
Boston (Back Bay),	26.36	Separate and combined,	1,810	19.70	35,655	36,030	1.15	1.61	99.0	71.4
Boston (Brighton),	62.49	Separate and combined,	3,896	7.00	27,270	38,640	3.19	3.74	70.6	85.3
Brookline,	73.07	Separate and combined,	4,810	7.25	34,870	35,280	3.58	6.81	98.8	52.6
Newton,	125.61	Separate,	7,379	5.70	42,060	44,300	7.69	16.88	94.9	45.6
Watertown,	44.61	Separate,	2,730	- 5.30	14,470	17,500	2.28	4.04	82.3	56.4
Waltham,	47.36	Separate,	3,863	7.60	29,360	31,050	2.44	13.63	94.6	17.9
Boston (Dorchester),	56.67	Separate and combined,	5,884	8.10	47,660	79,070	2.50	4.89	60.3	51.1
Milton,	16.69	Separate and combined,	921	5.00	4,605	8,950	0.92	12.59	51.5	7.3
Boston (Hyde Park),	33.81	Separate,	2,361	7.20	17,000	18,930	1.58	4.57	89.8	34.6
Dedham,	17.30	Separate,	838	5.50	4,610	11,490 ²	0.86	9.40	40.1	9.1
Boston (Roxbury), ³	-	-	-	-	-	43,680	-	1.23	-	-
Boston (West Roxbury),	59.66	Separate and combined,	3,954	7.10	30,040 ⁴	41,200	2.68	8.92	72.9	30.0
Quincy,	77.68	Separate,	5,548	5.30	29,405	42,570	3.31	12.56	69.1	26.4
Wellesley, ⁵	-	-	-	-	-	6,880	-	9.89	-	-
Totals,	641.31	-	43,994	7.20	317,005	455,630	32.18	110.76	69.6	29.1

¹ Estimated from assessors' statement of the number of houses in each city or town on April 1, 1916, and the population from census of 1915.

² Part of town not included in Metropolitan Sewerage District.

³ At present connected with Boston Main Drainage System.

⁴ Including connection with institutions at Austin Farm, having an estimated population of 1,964.

⁵ Wellesley not yet connected with metropolitan sewer.

BOTH METROPOLITAN SEWERAGE SYSTEMS.

Table showing Areas delivering Sewage to both Systems; Approximate Miles of Sewers connected; Estimated Population and Areas now contributing; Total Areas ultimately to contribute, and Present Populations on Such Areas; ratios of Present Contributing Areas to Ultimate Areas, and Ratios of Populations now contributing to Present Total Populations.

[Populations estimated as of December 31, 1916.]

SYSTEM.	Miles of Local Sewers connected.	Separate or Combined.	Number of Connections with Local Sewers.	Estimated Number of Persons served by Each House Connection.	Estimated Population now contributing Sewage.	Estimated Present Total Population.	Estimated Area now contributing Sewage.	Area ultimately contribute Sewage.	Ratio of Contributing Population to Present Total Population.	Ratio of Contributing Area to Ultimate Area.
North Metropolitan,	761.76	Separate and combined,	82,916	6.7	557,160	620,070	Sq. Miles. 32.20	Sq. Miles. 100.32	Per Cent. 89.9	Per Cent. 32.1
South Metropolitan,	641.31	Separate and combined,	43,994	7.2	317,005	455,630	32.18	110.76	69.6	29.1
Totals, . . .	1,403.07	- -	126,910	6.9	874,165	1,075,700	64.38	211.08	81.3	30.5

PUMPING STATIONS.

CAPACITY AND RESULTS.

Owing to the heavy rainfall of the earlier part of 1916 the pumping at the stations of the Metropolitan Sewerage Works increased in amounts varying from 9.8 per cent. to 23.7 per cent. as compared with 1915.

The increase in the price of coal affected only the latter half of the year.

A slight increase in engineers' wages was made in the Deer Island, East Boston and Charlestown pumping stations.

The expense per million foot gallons pumped at the stations of the Sewerage Works is substantially below that of last year.

Average Daily Volume of Sewage lifted at Each of the Six Principal Metropolitan Pumping Stations and at the Quincy (Hough's Neck) Sewage Lifting Station during the Year, as compared with the Corresponding Volumes for the Previous Year.

PUMPING STATION.	AVERAGE DAILY PUMPAGE.			
	Jan. 1, 1915, to Dec. 31, 1915.	Jan. 1, 1916, to Dec. 31, 1916.	Increase during the Year.	
	Gallons.	Gallons.	Gallons.	Per Cent.
Deer Island,	60,392,000	66,300,000	5,908,000	9.8
East Boston,	58,392,000	64,300,000	5,908,000	10.1
Charlestown,	33,500,000	37,300,000	3,800,000	11.3
Alewife Brook,	3,371,000	3,847,000	476,000	14.1
Quincy,	3,865,000	4,780,000	915,000	23.7
Ward Street (actual gallons pumped), .	26,933,000	29,864,000	2,931,000	10.9
Quincy (Hough's Neck) sewage lifting station.	177,700	187,238	9,538	5.4

NORTH METROPOLITAN SYSTEM.

Deer Island Pumping Station.

At this station are four submerged centrifugal pumps with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons, with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 59,400,000 foot-pounds.

Average quantity raised each day: 66,300,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 4 oilers, 3 screenmen, 1 relief screenman and 1 laborer.

Coal used: New River, costing from \$4.21 to \$5.92 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Deer Island Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1916.						
January,	2,090,100,000	67,400,000	51,800,000	109,300,000	11.36	61,700,000
February,	2,087,300,000	72,000,000	51,100,000	162,000,000	11.63	54,500,000
March,	2,579,800,000	83,200,000	63,500,000	113,300,000	11.86	61,300,000
April,	2,533,200,000	84,400,000	70,800,000	108,300,000	12.21	62,000,000
May,	2,333,700,000	75,300,000	56,500,000	123,700,000	11.21	62,000,000
June,	2,236,200,000	74,500,000	62,200,000	99,200,000	11.33	58,000,000
July,	2,037,400,000	65,700,000	53,700,000	88,200,000	11.26	70,600,000
August,	1,859,100,000	60,000,000	46,500,000	76,100,000	10.93	62,800,000
September,	1,614,900,000	53,800,000	45,300,000	71,400,000	10.30	49,700,000
October,	1,571,500,000	50,700,000	39,500,000	58,500,000	11.01	60,100,000
November,	1,586,600,000	52,900,000	45,100,000	64,800,000	11.01	52,300,000
December,	1,737,800,000	56,100,000	41,600,000	87,400,000	11.06	57,200,000
Total,	24,267,600,000	-	-	-	-	-
Average,	-	66,300,000	52,300,000	96,900,000	11.26	59,400,000

Average Cost per Million Foot-gallons for Pumping at the Deer Island Station.

Volume (24,267.6 Million Gallons) \times Lift (11.26 Feet) = 273,253.2 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$17,216 44	\$0.06301
Coal,	11,231 36	.04111
Oil,	309 60	.00113
Waste,	156 52	.00057
Water,	1,364 80	.00499
Packing,	138 51	.00051
Miscellaneous supplies and renewals,	1,341 33	.00491
Totals,	\$31,758 56	\$0.11623
Labor at screens,	\$3,249 89	-

East Boston Pumping Station.

At this station are four submerged centrifugal pumps, with impeller wheels 8.25 feet in diameter, driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 100,000,000 gallons with 19-foot lift.

Contract capacity of 3 pumps: 45,000,000 gallons each, with 19-foot lift.

Average duty for the year: 76,500,000 foot-pounds.

Average quantity raised each day: 64,300,000 gallons.

Force employed: 4 engineers, 2 relief engineers, 3 firemen, 1 relief fireman, 4 oilers, 3 screenmen, 1 relief screenman, 3 helpers and 1 laborer.

Coal used: New River, costing from \$4.17 to \$5.67 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the East Boston Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1916.						
January,	2,028,100,000	65,400,000	49,800,000	107,300,000	14.82	67,700,000
February,	2,029,300,000	70,000,000	49,100,000	160,000,000	14.83	76,400,000
March,	2,517,800,000	81,200,000	61,500,000	111,300,000	15.27	82,000,000
April,	2,473,200,000	82,400,000	68,800,000	106,300,000	15.35	74,100,000
May,	2,271,700,000	73,300,000	54,500,000	121,700,000	15.12	75,000,000
June,	2,176,200,000	72,500,000	60,200,000	97,200,000	15.01	73,200,000
July,	1,975,400,000	63,700,000	51,700,000	86,200,000	14.96	78,500,000
August,	1,797,100,000	58,000,000	44,500,000	74,100,000	14.88	83,500,000
September,	1,554,900,000	51,800,000	43,300,000	69,400,000	14.81	71,200,000
October,	1,509,500,000	48,700,000	37,500,000	56,500,000	14.69	78,300,000
November,	1,526,600,000	50,900,000	43,100,000	62,800,000	14.96	79,700,000
December,	1,675,800,000	54,100,000	39,600,000	85,400,000	14.88	73,900,000
Total,	23,535,600,000	—	—	—	—	—
Average,	—	64,300,000	50,300,000	94,900,000	14.96	76,500,000

Average Cost per Million Foot-gallons for Pumping at the East Boston Station.

Volume (23,535.6 Million Gallons) \times Lift (14.96 feet) = 352,092.6 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$21,185 75	\$0.06017
Coal,	11,972 14	.03401
Oil,	395 68	.00112
Waste,	74 11	.00021
Water,	1,491 60	.00423
Packing,	62 39	.00018
Miscellaneous supplies and renewals,	1,327 08	.00377
Totals,	\$36,508 75	\$0.10369
Labor at screens,	-\$1,372 50	-

Charlestown Pumping Station.

At this station are three submerged centrifugal pumps, two of them having impeller wheels 7.5 feet in diameter, the other 8.25 feet in diameter. They are driven by triple-expansion engines of the Reynolds-Corliss type.

Contract capacity of 1 pump: 60,000,000 gallons with 8-foot lift.

Contract capacity of 2 pumps: 22,000,000 gallons each, with 11-foot lift.

Average duty for the year: 51,300,000 foot-pounds.

Average quantity raised each day: 37,300,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 3 oilers, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$4.53 to \$5.75 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Charlestown Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1915.						
January,	1,186,900,000	38,300,000	30,100,000	60,300,000	8.42	52,800,000
February,	1,107,400,000	38,200,000	25,500,000	73,200,000	8.01	50,300,000
March,	1,335,200,000	43,100,000	33,300,000	56,400,000	8.52	51,500,000
April,	1,308,200,000	43,600,000	34,500,000	63,700,000	8.63	46,400,000
May,	1,280,100,000	41,300,000	31,500,000	69,000,000	8.71	51,800,000
June,	1,234,200,000	41,100,000	33,600,000	53,200,000	7.96	49,000,000
July,	1,195,300,000	38,600,000	28,500,000	49,500,000	8.47	57,200,000
August,	1,075,200,000	34,700,000	26,600,000	47,700,000	8.08	51,200,000
September,	1,006,100,000	33,500,000	25,200,000	44,400,000	8.15	52,600,000
October,	952,400,000	30,700,000	22,800,000	44,700,000	8.09	55,000,000
November,	899,400,000	30,000,000	22,400,000	39,900,000	8.21	47,200,000
December,	1,066,700,000	34,400,000	24,500,000	52,700,000	8.21	50,800,000
Total,	13,647,100,000	—	—	—	—	—
Average,	—	37,300,000	28,200,000	54,600,000	8.29	51,300,000

Average Cost per Million Foot-gallons for Pumping at the Charlestown Station.

Volume (13,647.1 Million Gallons) × Lift (8.29 Feet) = 113,134.5 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$14,514 39	\$0.12829
Coal,	5,349 00	.04728
Oil,	111 44	.00099
Waste,	55 67	.00049
Water,	716 40	.00633
Packing,	36 30	.00032
Miscellaneous supplies and renewals,	398 76	.00353
Totals,	\$21,181 96	\$0.18723
Labor at screens,	\$3,305 00	—

Alewife Brook Pumping Station.

The plant at this station consists of two 9-inch Andrews commercial centrifugal pumps, direct connected by horizontal shafts to compound marine engines, together with a pump and engine added later. The latter consists of a specially designed engine of the vertical cross-compound type, having between the cyclinders a centrifugal pump rotating on a horizontal axis.

Contract capacity of the 2 original pumps: 4,500,000 gallons each, with 13-foot lift.

Contract capacity of new pump: 13,000,000 gallons, with 13-foot lift.

Average duty for the year: 18,300,000 foot-pounds.

Average quantity raised each day: 3,847,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$4.89 to \$10.00 per gross ton.

Table of Approximate Quantities, Lifts and Duties at the Alewife Brook Pumping Station of the North Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1916.						
January,	129,891,000	4,190,000	3,329,000	6,931,000	12.97	18,400,000
February,	120,190,000	4,144,000	3,229,000	9,055,000	13.00	18,000,000
March,	161,319,000	5,204,000	4,318,000	7,049,000	13.07	21,200,000
April,	193,573,000	6,452,000	5,364,000	7,993,000	12.99	25,100,000
May,	167,996,000	5,419,000	4,026,000	8,347,000	12.90	22,400,000
June,	148,996,000	4,967,000	3,622,000	6,754,000	12.90	22,200,000
July,	118,989,000	3,838,000	2,978,000	4,860,000	12.83	19,400,000
August,	79,952,000	2,579,000	2,246,000	3,622,000	13.04	15,700,000
September,	70,531,000	2,351,000	2,035,000	3,330,000	12.97	14,300,000
October,	70,936,000	2,288,000	2,078,000	3,179,000	12.98	14,300,000
November,	67,693,000	2,256,000	1,994,000	3,622,000	13.04	13,800,000
December,	76,838,000	2,479,000	2,078,000	4,027,000	13.09	14,400,000
Total,	1,406,904,000	—	—	—	—	—
Average,	—	3,847,000	3,108,000	5,731,000	12.98	18,300,000

Average Cost per Million Foot-gallons for Pumping at the Alewife Brook Station.

Volume (1,406,904 Million Gallons) \times Lift (12.98 Feet) = 18,261.61 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$7,283 67	\$0.39885
Coal,	2,266 24	.12410
Oil,	122 25	.00670
Waste,	94 54	.00518
Water,	202 56	.01109
Packing,	7 36	.00040
Miscellaneous supplies and renewals,	43 39	.00265
Totals,	\$11,850 01	\$0.54897
Labor at screens, oiling and miscellaneous services,	\$1,825 00	-

SOUTH METROPOLITAN SYSTEM.

Ward Street Pumping Station.

At this station are two vertical, triple-expansion pumping engines, of the Allis-Chalmers type, operating reciprocating pumps, the plungers of which are 48 inches in diameter with a 60-inch stroke.

Contract capacity of 2 pumps: 50,000,000 gallons each, with 45-foot lift.

Average duty for the year: 87,474,000 foot-pounds.

Average quantity raised each day: 29,864,000 gallons.

Force employed: 4 engineers, 1 relief engineer, 4 firemen, 5 oilers, 4 assistant engineers, 1 machinist and 1 laborer.

Coal used: New River, costing from \$4.81 to \$5.68 per gross ton.

Material intercepted at screens during the year, 1,465.2 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Ward Street Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1916.						
January,	938,603,000	30,278,000	25,213,000	42,627,000	42.62	96,507,000
February,	883,450,000	30,464,000	24,396,000	56,896,000	42.42	92,193,000
March,	1,223,405,000	39,465,000	32,825,000	47,172,000	42.57	97,767,000
April,	1,210,016,000	40,334,000	34,710,000	49,650,000	43.22	107,431,000
May,	1,155,592,000	37,275,000	30,763,000	50,989,000	43.46	104,422,000
June,	1,430,012,000	34,767,000	29,593,000	45,131,000	43.47	97,084,000
July,	963,478,000	31,080,000	27,147,000	35,306,000	43.01	85,662,000
August,	741,402,000	23,939,000	19,332,000	33,066,000	42.11	72,837,000
September,	666,897,000	22,230,000	19,394,000	27,902,000	42.11	73,454,000
October,	705,274,000	22,751,000	19,386,000	30,340,000	42.21	69,202,000
November,	669,384,000	22,313,000	18,519,000	31,393,000	41.91	76,569,000
December,	727,792,000	23,477,000	20,199,000	34,927,000	41.53	76,555,000
Total,	11,315,305,000	—	—	—	—	—
Average,	—	29,864,000	25,123,000	40,450,000	42.56	87,474,000

Records from plunger displacements.

Average Cost per Million Foot-gallons for Pumping at the Ward Street Station.

Volume (11,315.3 Million Gallons) \times Lift (42.56 Feet) = 481,579.17 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$17,715 99	\$0.03679
Coal,	11,982 18	.02488
Oil,	246 69	.00051
Waste,	36 80	.00008
Water,	1,531 20	.00318
Packing,	427 61	.00089
Miscellaneous supplies and renewals,	499 89	.00104
Totals,	\$32,440 36	\$0.06737
Labor at screens,	\$4,340 87	—

Quincy Pumping Station.

At this station are two compound condensing Deane pumping engines and one Lawrence centrifugal pump driven by a Sturtevant compound condensing engine.

Contract capacity of 3 pumps: Deane, 3,000,000 gallons; Deane, 5,000,000 gallons; Lawrence centrifugal, 10,000,000 gallons.

Average duty for the year: 33,000,000 foot-pounds.

Average quantity raised each day: 4,780,000 gallons.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: Sterling Elmora, costing from \$4.72 to \$6.50 per gross ton.

Materials intercepted at screen during the year, 259 cubic yards.

Table of Approximate Quantities, Lifts and Duties at the Quincy Pumping Station of the South Metropolitan System.

MONTHS.	Total Pumpage (Gallons).	Average per Day (Gallons).	Minimum Day (Gallons).	Maximum Day (Gallons).	Average Lift (Feet).	Average Duty (ft.-lbs. per 100 lbs. Coal).
1916.						
January,	137,933,000	4,449,000	3,934,000	5,443,000	21.04	29,800,000
February,	146,217,000	5,042,000	3,782,000	12,497,000	21.84	30,800,000
March,	207,970,000	6,709,000	5,122,000	12,382,000	24.78	33,200,000
April,	228,857,000	7,628,000	6,048,000	11,479,000	29.23	38,700,000
May,	199,628,000	6,440,000	5,039,000	9,317,000	27.29	38,700,000
June,	172,776,000	5,759,000	4,705,000	9,794,000	23.82	37,800,000
July,	160,718,000	5,184,000	4,542,000	6,208,000	22.51	38,400,000
August,	140,540,000	4,532,000	3,599,000	5,472,000	21.33	35,700,000
September,	102,276,000	3,409,000	2,859,000	3,864,000	21.03	31,800,000
October,	87,880,000	2,835,000	2,549,000	3,159,000	21.02	28,800,000
November,	77,240,000	2,575,000	2,400,000	2,815,000	21.01	27,300,000
December,	86,609,000	2,794,000	2,551,000	3,346,000	20.97	24,700,000
Total,	1,748,644,000	—	—	—	—	—
Average,	—	4,780,000	3,928,000	7,148,000	* 22.99	33,000,000

Average Cost per Million Foot-gallons for Pumping at the Quincy Station.

Volume (1,748.6 Million Gallons) \times Lift (22.99 Feet) = 40,200.3 Million Foot-gallons.

ITEMS.	Cost.	Cost per Million Foot-gallons.
Labor,	\$6,564 02	\$0.16328
Coal,	2,466 10	.06134
Oil,	30 68	.00076
Waste,	34 04	.00084
Water,	324 87	.00808
Packing,	40 51	.00101
Miscellaneous supplies and renewals,	297 75	.00741
Totals,	\$9,757 97	\$0.24272
Labor at screens, oiling and miscellaneous services,	\$1,820 21	-

Nut Island Screen-house.

The plant at this house includes two sets of screens in duplicate actuated by small reversing engines of the Fitchburg type. Two vertical Deane boilers, 80 horse-power each, operate the engines, provide heat and light for the house, burn materials intercepted at the screens, and furnish power for the Quincy (Hough's Neck) sewage lifting station.

Average daily quantity of sewage passing screens, 62,000,000 gallons.

Total materials intercepted at screens, 1,170.4 cubic yards.

Materials intercepted per million gallons of sewage discharge, 1.40 cubic feet.

Force employed: 3 engineers, 1 relief engineer, 3 screenmen and 1 relief screenman.

Coal used: New River, costing from \$4.75 to \$6.60 per gross ton.

Quincy (Hough's Neck) Sewage Lifting Station.

At this station are two 6-inch submerged Lawrence centrifugal pumps with vertical shafts actuated by two Sturtevant direct-current motors.

The labor and electric energy for this station are supplied from the Nut Island screen-house and as used at present it does not materially increase the amount of coal used at the latter station. The effluent is largely ground water.

Contract capacity of 2 pumps: about 1,500,000 gallons each, with 20-foot lift.

Average daily amount pumped: 187,238 gallons.

Average lift: 15.59 feet.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton. ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
New England Coal & Coke Company.	738	-	-	-	-	-	-	\$4 21
New England Coal & Coke Company.	125	-	-	-	-	-	-	4 22
New England Coal & Coke Company.	385	-	-	-	-	-	-	4 23
New England Coal & Coke Company.	395	-	-	-	-	-	-	5 90
New England Coal & Coke Company.	993	-	-	-	-	-	-	5 92
New England Coal & Coke Company.	-	729	-	-	-	-	-	4 17
New England Coal & Coke Company.	-	575	-	-	-	-	-	4 20
New England Coal & Coke Company.	-	1,340	-	-	-	-	-	4 21
New England Coal & Coke Company.	-	485	-	-	-	-	-	5 65
New England Coal & Coke Company.	-	369	-	-	-	-	-	5 67
Metropolitan Coal Company, .	-	-	290	-	-	-	-	4 53
Metropolitan Coal Company, .	-	-	370	-	-	-	-	4 54
New England Coal & Coke Company.	-	-	308	-	-	-	-	5 75
Locke Coal Company, . . .	-	-	-	26	-	-	-	4 89
Locke Coal Company, . . .	-	-	-	105	-	-	-	5 13
Locke Coal Company, . . .	-	-	-	152	-	-	-	5 15
Locke Coal Company, . . .	-	-	-	55	-	-	-	5 79
Locke Coal Company, . . .	-	-	-	45	-	-	-	5 88
Locke Coal Company, . . .	-	-	-	50	-	-	-	10 00
Staples Coal Company, . .	-	-	-	-	180	-	-	4 81
Staples Coal Company, . .	-	-	-	-	222	-	-	4 90
Staples Coal Company, . .	-	-	-	-	385	-	-	4 95
Staples Coal Company, . .	-	-	-	-	68	-	-	4 97
Staples Coal Company, . .	-	-	-	-	346	-	-	4 99
Staples Coal Company, . .	-	-	-	-	303	-	-	5 00
Staples Coal Company, . .	-	-	-	-	118	-	-	5 59
Staples Coal Company, . .	-	-	-	-	70	-	-	5 64
Staples Coal Company, . .	-	-	-	-	207	-	-	5 65
Staples Coal Company, . .	-	-	-	-	444	-	-	5 68
Frost Coal Company, . . .	-	-	-	-	-	115	-	4 72
Frost Coal Company, . . .	-	-	-	-	-	43	-	4 77

¹ Includes adjustments for quality.

Coal delivered in the Bins of the Sewerage Works Pumping Stations during the Year
— Concluded.

	GROSS TONS, BITUMINOUS COAL.							Price per Gross Ton, ¹
	Deer Island Pumping Station.	East Boston Pumping Station.	Charlestown Pumping Station.	Alewife Brook Pumping Station.	Ward Street Pumping Station.	Quincy Pumping Station.	Nut Island Screen-house.	
Frost Coal Company, . . .	-	-	-	-	-	73	-	\$4 78
Frost Coal Company, . . .	-	-	-	-	-	43	-	5 00
Frost Coal Company, . . .	-	-	-	-	-	53	-	5 01
Frost Coal Company, . . .	-	-	-	-	-	54	-	5 04
Gorman- Leonard Coal Company,	-	-	-	-	-	521	-	5 93
Frost Coal Company, . . .	-	-	-	-	-	10	-	6 50
Maritime Coaling Company, .	-	-	-	-	-	-	198	4 75
Gorman-Leonard Coal Company,	-	-	-	-	-	-	300	6 60
Total gross tons, . . .	2,634	3,498	968	433	2,343	912	498	
Average price per gross ton, .	\$5 11	\$4 55	\$4 92	\$5 85	\$5 21	\$5 56	\$5 87	

¹ Includes adjustments for quality.

METROPOLITAN SEWERAGE OUTFALLS.

The original Deer Island outfall was put into operation in May, 1895. Sewage has been discharged through this outfall continuously except for the period between October 16, 1916, and December 15, 1916. This outfall is in good condition. The changes contemplated at this point are occasioned by the improvement in the method of dilution and not because of the failure of the structure.

The 60-inch outfalls of the South Metropolitan System, two of which were completed in 1904 and the third one in 1915, are in good condition and free from deposit.

During the year the average flow through the North Metropolitan outfall at Deer Island has been 66,300,000 gallons of sewage per 24 hours, with a maximum rate of 157,300,000 gallons during the stormy period in March, 1916. The amount of sewage discharged in the North Metropolitan District averaged 119 gallons per day for each person, taking the estimated population of the district contributing sewage. If the sewers in this district were restricted to

the admission of sewage proper only, this per capita amount would be considerably decreased.

In the South Metropolitan District an average of 62,000,000 gallons of sewage has passed daily through the screens at the Nut Island screen-house, and has been discharged from the outfalls into the outer harbor. The maximum rate of discharge per day, which occurred during a heavy storm on February 26, 1916, was 178,000,000 gallons. The discharge of sewage through these outfalls represents the amount of sewage contributed in the South Metropolitan System, which was at the rate of 196 gallons per day per person of the estimated number contributing sewage in the district.

The daily discharge of sewage per capita is considerably larger in the South Metropolitan District than it is in the North Metropolitan District, because, owing to the large size of the High-level Sewer, more storm water is at present admitted to the sewers.

Material Intercepted at the Screens.

The material intercepted at the screens at the North Metropolitan Sewerage stations, consisting of rags, paper and other floating materials, has during the year amounted to 2,315 cubic yards. This is equivalent to 2.576 cubic feet for each million gallons of sewage pumped at Deer Island.

The material intercepted at the screens at the South Metropolitan Sewerage stations has amounted to 2,894.6 cubic yards, equal to 3.44 cubic feet per million gallons of sewage delivered at the outfall works at Nut Island.

Studies of sewage flows in the Metropolitan sewers and siphons indicate that they are free from deposit.

FREDERICK D. SMITH,
Chief Engineer of Sewerage Works.

BOSTON, January 1, 1917.

APPENDIX.

APPENDIX No. 1.

CONTRACTS MADE AND PENDING DURING

[NOTE. — The details of contracts made before

1.	Number of Contract.	2.	WORK.	3.	Num-ber of Bids.	AMOUNT OF BID.		6.	Contractor.
						4.	5.		
						Next to Lowest.	Lowest.		
1	364 ¹		Furnishing and installing hydraulic machinery at Sudbury Dam, Southborough.	3		\$13,737 00	\$11,760 00 ²		S. Morgan Smith Co., York, Penn.
2	364-A ¹		Furnishing and installing electric machinery at Sudbury Dam, Southborough.	3		22,112 00	19,349 00 ²		Westinghouse Electric & Mfg. Co., Pittsburgh, Penn.
3	368 ¹		Masonry tower on Bellevue Hill, Boston.	11		46,900 00	46,000 00 ²		John Cashman & Sons Co., Boston.
4	369 ¹		Laying 60-inch water pipes in Newton.	11		32,615 00	32,369 00 ²		Andrew M. Cusack, Boston.
5	373 ¹		Underground cable for hydro-electric plant at Sudbury Dam.	1 ⁴		—	1,182 61		Safety Insulated Wire & Cable Co., Boston.
6	374		75 tons special castings,	4		5,250 00	5,100 00 ²		Standard Cast Iron Pipe & Foundry Co., Bristol, Penn.
7	375		Venturi meter tubes, registers and parts.	— ⁵		— ⁵	— ⁵		Builders Iron Foundry, Providence, R. I.
8	376		Improvement of Beaver Dam Brook.	9 ⁶		50,437 00	49,732 50	—	—
9	377		Water valves: 5 36-inch, 2 30-inch, 4 16-inch and 5 12-inch screw lift valves.	3		8,100 00	6,965 00 ²		Coffin Valve Co., Boston.
10	378		Check valves: 3 30-inch, 1 20-inch and 1 10-inch check valves.	4		1,535 00	1,527 00 ²		Ludlow Valve Mfg. Co., Troy, N. Y.
11	378-A		Check valves: 2 48-inch and 1 36-inch check valves.	3		3,072 00	2,350 00 ²		Coffin Valve Co., Boston.

¹ Contract completed.² Contract based upon this bid.³ Completed except for guarantee with regard to defects that may become manifest during first year of operation.

APPENDIX No. 1.

THE YEAR 1916 — WATER WORKS.

1916 have been given in previous reports.]

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1916.	
June 23, 1915	July 5, 1916 ²	See previous report,	\$13,268 53	1
June 23, 1915	Dec. 15, 1916 ²	See previous report,	20,091 91	2
Apr. 23, 1915	July 11, 1916	See previous report,	46,436 05	3
Apr. 30, 1915	Jan. 13, 1916	See previous report,	49,210 01	4
Dec. 2, 1915	May 25, 1916	See previous report,	1,182 61	5
June 19, 1916	-	For all special castings, \$68 per ton of 2,000 pounds, .	1,800 00	6
June 16, 1916	-	For 1 10-inch and 1 20-inch meter tube without throat section; 1 10-inch throat for 30-inch meter tube and 1 18-inch throat for 48-inch meter tube with gears for adapting Type D registers of larger sizes for use with these tubes; 1 30-inch and 1 36-inch meter tube complete; gears for adapting Type D register now used with 48-inch meter tube for use with a 36-inch meter tube, and 2 sets of short arms for Type D registers, \$3,395.	2,320 00	7
-	-	-	-	8
July 31, 1916	-	For 36-inch screw lift valves, \$865 each; for 30-inch screw lift valves, \$615 each; for 16-inch screw lift valves, \$190 each, and for 12-inch screw lift valves, \$130 each.	3,500 00	9
Aug. 2, 1916	-	For 30-inch check valves, \$465 each; for 20-inch check valve, \$93, and for 10-inch check valve, \$34.	1,250 00	10
July 31, 1916	-	For 48-inch check valves, \$850 each; for 36-inch check valve, \$650.	1,400 00	11

¹ Two other proposals received which did not conform to requirements of specifications.² Competitive bids not received.³ All bids rejected as they exceeded the amount appropriated for this work.

CONTRACTS MADE AND PENDING DURING

1. Number of Contract.	2. WORK.	3. Number of Bids.	AMOUNT OF BID.		6. Contractor.
			4. Next to Lowest.	5. Lowest.	
12 379	Street chambers for Venturi meter chambers; 6 chambers.	2	\$2,022 00	\$1,650 00 ²	Daniel Russell Boiler Works, Boston.
13 380 ¹	Steelwork for chambers for 36-inch valves; 14 sets.	4	1,148 00	966 00 ²	New England Structural Co., Boston.
14 381 ¹	Cast-iron frames and covers; about 33,000 pounds.	1	—	907 50 ²	F. A. Houdlette & Son, Boston.
15 22-M ¹	Sale and purchase of electric energy to be developed at Wachusett Dam.	3	—	\$5.30 ⁷ per thousand kilowatt hours.	Connecticut River Transmission Co., Boston.
16 39-M	Sale and purchase of electric energy to be developed at the Sudbury Dam.	2	— ⁹	— ⁹	Edison Electric Illuminating Co. of Boston.
17 40-M ¹	800 tons bituminous coal for Spot Pond pumping station.	2	\$5.25 per ton.	\$5.10 ² per ton.	Bader Coal Co., Boston.
18 41-M ¹	5,000 tons bituminous coal for Chestnut Hill pumping stations and 80 tons for Pegan pumping station, Natick.	Chestnut Hill stations, 6. Pegan station, 4.	— ¹⁰	— ¹⁰	H. N. Hartwell & Son, Boston.
19 43-M ¹	450 tons bituminous coal for Arlington pumping station.	4	\$4.30 ² per ton.	\$4.25 per ton.	Hetherington & Co., Philadelphia, Penn.
20 45-M ¹	Electrically operated sluice gates for Sudbury power plant.	3	4,125 00	3,915 00 ²	Coffin Valve Co., Boston.
21 46-M	1,500 tons anthracite coal for Chestnut Hill pumping stations.	— ⁵	— ⁵	— ⁵	C. W. Claffin & Co., Boston.
22 47-M	450 tons bituminous coal for Arlington pumping station, and 120 tons for Hyde Park pumping station.	Arlington station, 3. Hyde Park station, 2.	\$4.78 per ton.	\$4.70 ² per ton.	Garfield & Proctor Coal Co., Boston.
23 48-M	800 tons bituminous coal for Spot Pond pumping station, 120 tons at the Natick station on the B. & A. R.R. and 40 tons at the Clinton station on the B. & M. R.R.	Spot Pond station, 3. Natick, 2. Clinton, 2.	\$6.16 per ton.	\$5.60 ² per ton.	Hetherington & Co., Philadelphia, Penn.
			\$6.00 per ton.	\$4.58 ² per ton.	
			\$6.00 per ton.	\$4.83 ² per ton.	

¹ Contract completed.² Contract based upon this bid.⁵ Competitive bids not received.⁷ Highest bid.⁸ Amount received for energy sold.

THE YEAR 1916 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1916.	
Oct. 31, 1916	—	For each chamber, \$275,	\$825 00	12
Oct. 31, 1916	Dec. 29, 1916	For steelwork for chambers for 36-inch valves, \$69 per set.	961 17	13
Oct. 31, 1916	Dec. 29, 1916	For castings, 23¼ cents per pound,	913 36	14
Sept. 14, 1910	Sept. 30, 1916	\$5.30 per thousand kilowatt hours,	162,934 82 ^s	15
Dec. 21, 1914	—	\$6.25 per thousand kilowatt hours. Delivery of energy began September 14, 1916.	6,663 21 ^s	16
June 15, 1915	May 24, 1916	See previous report,	4,177 16	17
June 15, 1915	May 24, 1916	See previous report,	21,294 12	18
June 15, 1915	May 12, 1916	See previous report,	1,961 45	19
Oct. 7, 1915	June 14, 1916	See previous report,	3,983 91	20
June 7, 1916	—	For Hudson Coal Company's D. & H. Birdseye coal, \$0.97 per ton of 2,240 pounds at the mines.	2,920 73	21
June 9, 1916	—	For Peacock coal, \$4.70 per ton of 2,240 pounds delivered on cars at the Arlington pumping station, and \$4.50 per ton of 2,240 pounds delivered on cars at the Hyde Park pumping station.	1,607 70	22
June 12, 1916	— ¹¹	For Brazil Smokeless coal, \$5.60 per ton of 2,240 pounds delivered in bins at the Spot Pond pumping station, \$4.58 per ton of 2,240 pounds on cars at the Natick station on the Boston & Albany Railroad, and \$4.83 per ton of 2,240 pounds on cars at the Clinton station on the Boston & Maine Railroad.	1,661 95	23

⁹ Contract based upon bid of \$6.25 per M. kilowatt hours for entire output. Bids of \$5.50 per M. kilowatt hours for at least one-third of output and of \$3 per M. kilowatt hours for at least two-thirds of output also received.

¹⁰ For Sterling Elmora or Riverside coal, \$3.97; for Davenport coal, \$3.98, and for Alpha Special coal, \$4 per ton.

¹¹ Delivery of coal terminated by appointment of a receiver.

CONTRACTS MADE AND PENDING DURING

	1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.
				4. Next to Lowest.	5. Lowest.	
24	49-M	4,500 tons bituminous coal for Chestnut Hill pumping stations.	3	\$4.33 per ton.	\$4.28 ² per ton.	E. Russell Norton, Boston.
25	50-M	Superstructure of garage at Chestnut Hill Reservoir.	11	8,100 00	8,018 00 ²	Crowley & Hickey, Boston.
26	Agreement. ¹	3 horizontal-type hydraulic governors.	- ⁵	- ⁵	- ⁵	Lombard Governor Co., Ashland, Mass.
27	Agreement.	Sale and purchase of electric energy to be developed at Wachusett Dam after expiration of Contract No. 22-M and until energy is delivered under new contract, proposals for which were received May 22, 1916, but under which energy cannot be delivered until a transmission line has been constructed by the Board.	-1 ²	-1 ²	-1 ²	New England Power Co., Boston.
28	Special Order. ¹	Tin plate roof for effluent gate house at Lake Cochituate.	9	209 00	178 00 ²	Framingham Construction and Supply Co., Framingham, Mass.
29	Special Order. ¹	Electrically operated gate stand for operating sluice gate at Sudbury power station, Southborough.	- ⁵	- ⁵	- ⁵	Coffin Valve Co., Boston.
30	Special Order. ¹	Oil tank for transformers at Sudbury power station, Southborough.	5	285 00	270 00 ²	Roberts Iron Works Co., Cambridge, Mass.
31	Special Order.	Plumbing at Sudbury power station, Southborough.	3	214 00	208 00 ²	J. B. Moulton, Framingham, Mass.

¹ Contract completed.² Contract based upon this bid.⁵ Competitive bids not received.⁶ Amount received for energy sold.

THE YEAR 1916 — WATER WORKS — *Continued.*

7. Date of Con- tract.	8. Date of Completion of Contract.	9. Prices of Principal Items of Contracts.	10. Value of Work done Dec. 31, 1916.	
June 15, 1916	-	For Davenport Miller Vein coal, \$4.28 per ton of 2,240 pounds delivered on cars at the Chestnut Hill pumping stations.	\$8,329 05	24
Sept. 29, 1916	-	For superstructure of garage complete, \$3,018, . . .	2,000 00	25
July 21, 1915	Aug. 5, 1916	See previous report,	2,404 00	26
Oct. 1, 1916	-	\$0.0053 per kilowatt hour,	8,835 89 ¹	27
Jan. 24, 1916	Apr. 13, 1916	For whole work, \$178,	178 00	28
Feb. 9, 1916	July 7, 1916	For whole work, \$450,	460 35	29
May 22, 1916	Sept. 13, 1916	For whole work, \$270,	270 00	30
Nov. 28, 1916	-	For whole work, \$208,	-	31
			<u>\$372,840 98</u>	

¹² Agreement made with the New England Power Company, with which the Connecticut River Transmission Company, the contractor under Contract No. 22-M, which was completed September 30, 1916, has been consolidated.

CONTRACTS MADE AND PENDING DURING THE YEAR 1916 — WATER WORKS —
Concluded.

Summary of Contracts, 1895 to 1916, inclusive. ¹

	Value of Work done Dec. 31, 1916.
Distribution Department, 10 contracts,	\$108,615 59
Sudbury Department, 3 contracts,	34,543 05
375 contracts completed from 1896 to 1915, inclusive,	17,246,018 99
	<hr/> \$17,389,177 63
Deduct for work done on 11 Sudbury Reservoir contracts by the city of Boston, .	512,000 00
Total of 388 contracts,	<hr/> \$16,877,177 63

¹ In this summary contracts charged to maintenance are excluded.

APPENDIX No. 2.

TABLE No. 1. — *Monthly Rainfall in Inches at Various Places on the Metropolitan Water Works, in 1916.*

PLACE.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
Wachusett Watershed.													
Princeton,	1.54	5.75	2.44	3.14	3.72	6.85	5.93	1.74	4.14	1.47	3.07	2.57	42.36
Jefferson,	1.77	6.42	3.99	3.78	4.24	6.61	6.53	1.78	4.31	1.53	3.43	3.07	47.46
Sterling,	1.55	5.72	3.03	3.73	1.90	6.26	4.67	1.62	3.76	1.25	3.22	2.84	39.55
Boylston,	1.54	6.04	3.83	3.96	3.49	6.53	5.50	1.73	4.03	1.42	2.88	2.76	44.36
Sudbury Dam,	1.51	5.92	4.02	4.15	3.44	4.90	5.18	2.26	2.02	1.37	2.23	3.20	40.20
Framingham,	1.50	5.93	3.95	4.09	3.54	4.65	5.11	2.00	1.69	1.45	2.25	3.13	39.29
Ashland Dam,	1.54	5.60	4.58	4.06	3.28	4.74	4.94	1.77	1.50	1.47	2.09	3.20	38.77
Cordaville,	1.57	6.21	4.08	4.46	3.45	4.79	5.47	2.01	1.97	1.65	2.55	3.36	41.57
Lake Cochituate,	1.52	5.66	4.62	4.12	3.20	5.45	3.89	1.75	1.30	1.28	2.18	3.18	38.15
Chestnut Hill Reservoir,	1.87	5.65	4.18	4.74	3.56	6.03	5.19	2.78	1.45	1.27	1.88	3.31	41.91
Spot Pond,	1.55	5.71	4.41	5.26	3.92	5.59	3.28	2.32	1.80	1.38	1.84	3.19	40.25
Average of all,	1.59	5.87	3.92	4.14	3.43	5.68	5.06	1.98	2.60	1.41	2.51	3.07	41.26
Average, Wachusett watershed,	1.60	5.98	3.32	3.65	3.34	6.57	5.66	1.72	4.21	1.42	3.15	2.81	43.43
Average, Sudbury watershed,	1.53	5.91	4.16	4.19	3.43	4.77	5.17	2.01	1.80	1.49	2.28	3.22	39.96

TABLE NO. 2. — *Rainfall in Inches at Jefferson, Mass., in 1916.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	²	—	—	—	—	—	—	—	—	—	0.12	—
2,	0.74 ¹	²	0.09 ¹	—	—	—	²	—	—	—	—	—
3,	—	²	—	—	²	0.88	0.65	—	—	—	—	—
4,	—	1.26 ¹	—	0.11 ³	0.67	—	²	—	—	—	²	—
5,	0.32	—	—	—	—	0.65	0.12	—	—	—	0.52	—
6,	—	—	²	²	0.12	—	—	—	0.26	—	—	—
7,	—	—	²	0.14 ³	0.09	²	—	—	—	—	—	0.07
8,	—	²	1.59 ³	²	0.17	²	²	0.43	0.14	—	—	—
9,	—	0.17 ¹	—	0.90 ¹	—	²	²	²	—	—	0.10	0.34
10,	0.21 ²	—	0.47 ¹	—	—	2.21	²	0.14	—	—	—	—
11,	—	²	—	—	—	0.30	0.70	0.17	—	—	—	²
12,	²	²	—	0.12 ³	—	0.20	—	—	—	—	—	0.85 ³
13,	0.17	1.37 ¹	0.76 ¹	—	—	—	0.34	0.13	—	0.27	²	—
14,	—	—	²	0.69 ³	²	²	—	—	—	—	0.36 ³	—
15,	—	—	0.52 ¹	—	²	²	—	—	2.86	—	—	0.63 ¹
16,	0.07 ¹	—	—	—	²	²	—	—	—	—	0.05 ¹	—
17,	—	—	—	0.09	2.65	1.26	²	—	—	0.08	0.09 ¹	—
18,	—	0.12 ¹	—	—	—	—	0.54	—	²	—	—	—
19,	—	—	—	—	—	0.60	—	—	0.50	0.98	—	—
20,	0.02 ³	—	0.01 ¹	—	—	—	²	—	—	—	—	—
21,	—	—	—	—	—	0.12	²	—	—	0.13	—	²
22,	0.08	—	²	²	—	—	²	—	—	—	—	1.06 ³
23,	—	²	0.55 ¹	²	0.26	—	2.41	0.46	—	—	1.26	—
24,	—	²	—	0.90	—	—	—	—	—	—	—	—
25,	—	3.50 ³	—	0.11	—	0.39	²	—	—	0.07	—	—
26,	—	—	—	—	—	—	²	—	—	—	—	—
27,	0.06	—	—	²	—	—	1.77	²	—	—	—	²
28,	—	—	—	0.72 ³	0.05	—	—	0.45	—	—	—	0.12
29,	—	—	—	—	—	—	—	—	0.55	—	²	—
30,	0.10	—	—	—	0.23	—	—	—	—	—	0.93	—
31,	—	—	—	—	—	—	—	—	—	—	—	—
Totals,	1.77	6.42	3.99	3.78	4.24	6.61	6.53	1.78	4.31	1.53	3.43	3.07

Total for the year, 47.46 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE No. 3. — *Rainfall in Inches at Framingham, Mass., in 1916.*

DAY OF MONTH.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1,	0.26 ³	-	2	-	-	-	-	-	-	-	0.04	-
2,	0.49 ³	2	0.25 ¹	-	-	-	-	-	-	-	-	-
3,	-	1.20 ¹	0.16 ¹	-	2	2	0.29	-	-	-	-	-
4,	-	-	0.02 ¹	0.17 ³	0.20	0.68	2	-	-	-	2	2
5,	0.15	-	-	-	2	0.13	0.39	-	2	-	0.20	0.08
6,	-	2	2	0.04	0.27	0.02	-	-	2	-	-	-
7,	-	0.04	0.75 ³	-	-	2	-	-	0.51	-	-	-
8,	-	2	0.63 ¹	2	0.02	2	2	2	2	-	-	-
9,	-	0.20 ¹	2	0.87 ³	-	2	2	2	0.15	-	-	0.26
10,	0.24 ³	-	0.27 ³	-	-	2	1.12	0.40	-	-	-	-
11,	-	0.32 ¹	-	2	-	1.16	0.11	0.16	-	-	-	2
12,	2	2	2	0.14	-	0.40	-	-	-	-	-	0.65 ³
13,	0.14	1.26 ¹	0.25 ¹	-	-	-	0.25	0.17	-	0.20	2	-
14,	-	-	2	0.68 ³	2	-	-	-	-	-	0.28 ³	-
15,	2	-	2	-	2	-	-	-	0.63	-	-	0.75 ¹
16,	0.02 ¹	0.10 ¹	0.93 ¹	-	2	2	-	-	-	-	0.03 ¹	-
17,	-	-	-	0.06	2.51	2	2	-	-	-	0.06 ¹	-
18,	-	0.22	2	0.04	-	1.37	0.36	-	2	-	-	-
19,	-	-	0.03 ¹	-	0.04	0.47	-	-	0.24	2	-	-
20,	0.01 ¹	-	2	-	0.05	-	2	-	-	0.93	-	-
21,	-	-	0.02 ¹	0.01	-	0.14	1.01	-	-	0.03	-	2
22,	0.03	-	0.60 ¹	2	2	-	2	-	0.02	-	-	1.22 ³
23,	-	0.07 ¹	-	2	2	-	0.75	0.52	-	-	0.67	-
24,	-	2	-	0.88	0.12	-	-	0.14	-	-	-	-
25,	-	2	-	2	-	0.28	2	-	-	0.26	-	-
26,	2	2.52 ³	-	0.20	-	-	2	-	-	-	-	-
27,	0.07	-	-	2	2	-	0.65	0.03	-	-	-	2
28,	-	-	-	1.00 ³	2	-	-	0.58	-	-	-	0.17 ³
29,	-	-	2	-	2	-	-	-	0.14	-	2	-
30,	2	-	0.04	-	0.33	-	-	-	-	-	0.97	-
31,	0.09	-	-	-	-	-	0.18	-	-	0.03	-	-
Totals,	1.50	5.93	3.95	4.09	3.54	4.65	5.11	2.00	1.69	1.45	2.25	3.13

Total for the year, 39.29 inches.

¹ Snow.² Rainfall included in that of following day.³ Rain and snow.

TABLE NO. 4. — *Rainfall in Inches at Chestnut Hill Reservoir, 1916.*

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Jan. 1, . . .	.26 ¹	7.15 A.M. to 10.45 A.M.	May 4, . . .	.16	12.35 A.M. to 7.30 A.M.
Jan. 1, . . .	.04	10.45 A.M. to 4.20 P.M.	May 6, . . .	.21	2.25 A.M. to 10.30 A.M.
Jan. 2, . . .	.62 ¹	2.35 A.M. to 10.20 A.M.	May 7, . . .	.03	8.15 P.M. to 8.35 P.M.
Jan. 2, . . .	.03	10.20 A.M. to 6.00 P.M.	May 8, . . .	.02	8.00 P.M. to 10.45 P.M.
Jan. 5, . . .	.16	5.50 A.M. to 11.15 P.M.	May 14, . . .	2.67	10.30 P.M. to
Jan. 10, . . .	.25 ¹	8.30 A.M. to 12.30 P.M.	May 17, . . .		2.45 P.M.
Jan. 10, . . .	.09	12.30 P.M. to 5.00 P.M.	May 20, . . .	.15	2.40 P.M. to 7.00 P.M.
Jan. 13, . . .	.18	6.10 A.M. to 11.20 A.M.	May 23, . . .	.07	4.05 A.M. to 5.00 P.M.
Jan. 16, . . .	.05 ¹	1.35 A.M. to 9.05 A.M.	May 27, . . .	.14	5.45 P.M. to
Jan. 22, . . .	.05	5.00 P.M. to 8.15 P.M.	May 29, . . .		7.30 A.M.
Jan. 27, . . .	.04	2.00 A.M. to 7.30 A.M.	May 30, . . .	.03	4.35 A.M. to 7.15 A.M.
Jan. 30, . . .	.10	3.00 P.M. to 10.00 P.M.	May 30, . . .	.08	4.50 P.M. to
			May 31, . . .		2.20 A.M.
	1.87			3.56	
Feb. 2, . . .	1.23 ¹	8.40 A.M. to	June 3, . . .	1.00	5.40 P.M. to
Feb. 3, . . .		12.30 P.M.	June 4, . . .		12.10 A.M.
Feb. 7, . . .	.03	1.20 A.M. to 5.35 A.M.	June 5, . . .	.10	2.30 P.M. to 9.00 P.M.
Feb. 8, . . .	.19 ¹	11.30 P.M. to 6.00 A.M.	June 6, . . .	.03	2.30 P.M. to 4.15 P.M.
Feb. 11, . . .	.33 ¹	3.15 P.M. to	June 7, . . .	.06	12.45 A.M. to 5.50 A.M.
Feb. 12, . . .	.90 ¹	5.20 A.M.	June 8, . . .	1.24	10.25 P.M. to
Feb. 13, . . .		8.00 P.M.	June 11, . . .	.52	7.30 A.M.
Feb. 16, . . .	.10 ¹	11.25 P.M. to	June 11, . . .		2.45 P.M. to
Feb. 17, . . .	.15	1.25 A.M.	June 13, . . .	2.04	2.15 P.M.
Feb. 18, . . .		3.00 P.M. to 8.00 P.M.	June 16, . . .		11.45 P.M. to
Feb. 23, . . .	.03 ¹	2.10 P.M. to 5.15 P.M.	June 17, . . .	.53	5.30 P.M.
Feb. 24, . . .	2.69 ²	8.40 P.M. to	June 19, . . .		1.50 P.M. to
Feb. 26, . . .		3.30 P.M.	June 20, . . .	.14	12.40 A.M.
	5.65		June 21, . . .		6.10 P.M. to 8.55 P.M.
Mar. 2, . . .	.37 ¹	3.55 A.M. to 2.45 P.M.	June 25, . . .	.37	1.50 A.M. to 10.15 P.M.
Mar. 3, . . .	.15 ¹	6.00 P.M. to		6.03	
Mar. 4, . . .	.06 ¹	3.10 A.M.	July 3, . . .	.21	12.25 A.M. to 5.20 A.M.
Mar. 5, . . .		2.00 A.M. to 4.05 A.M.	July 3, . . .	.71	2.40 P.M. to 6.20 P.M.
Mar. 6, . . .	.77 ¹	5.15 P.M. to	July 4, . . .	.43	7.45 A.M. to
Mar. 7, . . .	.05	4.20 A.M.	July 5, . . .	.66	1.30 P.M.
Mar. 7, . . .		4.20 A.M.	July 8, . . .		1.40 P.M. to
Mar. 8, . . .	.73 ¹	4.20 A.M. to 6.00 P.M.	July 10, . . .	.18	10.00 A.M.
Mar. 10, . . .	.22 ¹	12.45 P.M. to 11.35 P.M.	July 11, . . .		10.15 A.M. to 3.30 P.M.
Mar. 13, . . .	.19 ¹	5.50 A.M. to 12.30 P.M.	July 13, . . .	.21	3.00 P.M. to 8.00 P.M.
Mar. 14, . . .	1.02 ¹	1.35 A.M. to 8.30 A.M.	July 18, . . .	.23	3.55 A.M. to 6.15 A.M.
Mar. 16, . . .		6.30 P.M. to	July 20, . . .	.64	10.45 P.M. to
Mar. 16, . . .	.57 ¹	8.10 A.M.	July 21, . . .	.77	4.00 P.M.
Mar. 22, . . .		12.30 P.M. to	July 23, . . .		1.25 A.M. to
Mar. 23, . . .	.05	3.25 A.M.	July 24, . . .	.04	5.15 A.M.
Mar. 29, . . .		7.40 P.M. to 10.30 P.M.	July 25, . . .		12.15 A.M. to 2.50 A.M.
	4.18		July 25, . . .	.71	7.30 P.M. to
Apr. 4, . . .	.11 ²	7.15 A.M. to	July 27, . . .	.07	5.25 A.M.
Apr. 5, . . .	.03	7.30 A.M.	July 27, . . .		10.15 A.M. to 6.00 P.M.
Apr. 6, . . .		11.50 P.M. to	July 31, . . .	.33	4.10 P.M. to 4.35 P.M.
Apr. 7, . . .	.28 ²	2.25 A.M.		5.19	
Apr. 8, . . .		4.30 P.M. to	Aug. 8, . . .	.42	2.30 P.M. to 11.45 P.M.
Apr. 9, . . .	.21	4.50 A.M.	Aug. 9, . . .	.54	7.45 A.M. to
Apr. 9, . . .	.26 ¹	7.30 A.M. to 10.30 A.M.	Aug. 11, . . .	.22	5.00 A.M.
Apr. 9, . . .	.11	1.35 P.M. to 8.15 P.M.	Aug. 11, . . .		11.45 P.M. to
Apr. 12, . . .	.11	2.10 A.M. to 9.15 A.M.	Aug. 12, . . .	.14	4.30 A.M.
Apr. 14, . . .	.70 ²	8.40 A.M. to	Aug. 13, . . .		5.45 A.M. to 3.10 P.M.
Apr. 15, . . .		2.50 A.M.	Aug. 24, . . .	.09	8.05 A.M. to 10.00 A.M.
Apr. 17, . . .	.10	4.20 P.M. to	Aug. 27, . . .	.09	7.50 P.M. to 9.05 P.M.
Apr. 18, . . .		4.05 A.M.	Aug. 28, . . .	1.28	9.50 A.M. to 6.00 P.M.
Apr. 18, . . .	.03	4.40 P.M. to 10.00 P.M.		2.78	
Apr. 21, . . .	.02	7.20 A.M. to 10.20 A.M.			
Apr. 22, . . .	1.18	10.05 A.M. to			
Apr. 22, . . .		7.00 P.M.			
Apr. 24, . . .	.23	1.35 A.M. to			
Apr. 26, . . .		8.00 A.M.			
Apr. 27, . . .	1.48 ²	10.55 P.M. to			
Apr. 27, . . .		8.00 P.M.			
Apr. 28, . . .	4.74				

¹ Snow.² Rain and snow.

TABLE No. 4. — *Rainfall in Inches at Chestnut Hill Reservoir in 1916 —*
Concluded.

DATE.	Amount.	Duration.	DATE.	Amount.	Duration.
Sept. 5, . . .	.27	4.30 P.M. to 7.30 A.M.	Nov. 1, . . .	.04	9.30 A.M. to 11.15 A.M.
Sept. 7, . . .	.13	8.10 P.M. to 4.50 A.M.	Nov. 5, . . .	.15	4.15 A.M. to 10.50 A.M.
Sept. 8, . . .	.69	7.45 A.M. to 1.50 A.M.	Nov. 13, . . .	.23 ²	8.15 P.M. to 3.00 P.M.
Sept. 9, . . .	.12	9.30 P.M. to 5.20 A.M.	Nov. 14, . . .	.04 ¹	3.30 A.M. to 5.45 A.M.
Sept. 15, . . .	.24	7.45 P.M. to 2.25 A.M.	Nov. 15, . . .	.07 ²	4.15 P.M. to 11.40 P.M.
Sept. 16, . . .			Nov. 17, . . .	.50	12 Noon to 1.25 A.M.
Sept. 18, . . .			Nov. 23, . . .	.14	10.15 P.M. to 4.45 A.M.
Sept. 19, . . .			Nov. 24, . . .	.71	10.00 A.M. to 1.30 A.M.
Sept. 29, . . .			Nov. 29, . . .		
Sept. 30, . . .	1.45		Nov. 30, . . .		
			Dec. 1, . . .	1.88	
Oct. 13, . . .	.22	4.45 P.M. to 1.50 A.M.	Dec. 4, . . .	.10	6.45 A.M. to 7.15 A.M.
Oct. 14, . . .	.72	9.00 A.M. to 3.45 A.M.	Dec. 5, . . .	.34	4.15 P.M. to 12.40 A.M.
Oct. 19, . . .	.04	6.45 P.M. to 2.30 A.M.	Dec. 9, . . .	.72 ²	6.15 P.M. to 6.45 P.M.
Oct. 20, . . .	.13	9.30 A.M. to 10.05 A.M.	Dec. 10, . . .	.81 ¹	7.30 A.M. to 8.00 A.M.
Oct. 21, . . .	.16	12.05 A.M. to 2.30 A.M.	Dec. 11, . . .	.18 ¹	5.10 A.M. to 7.30 A.M.
Oct. 26, . . .	1.27		Dec. 12, . . .	.98	8.00 A.M. to 6.20 P.M.
			Dec. 15, . . .	.08	10.00 A.M. to 10.00 P.M.
			Dec. 16, . . .	.10	9.15 A.M. to 11.45 A.M.
			Dec. 21, . . .		
			Dec. 22, . . .		
			Dec. 27, . . .		
			Dec. 28, . . .		
				3.31	

Total for year, 41.91 inches.

¹ Snow.² Rain and snow.

TABLE No. 5. — *Rainfall in Inches on the Wachusett Watershed, 1897 to 1916.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1897.	8.65	3.47	1.93	0.94	7.62	6.41	51.84
1898.	3.11	3.01	10.61	3.15	7.21	6.81	3.99	57.92
1899.	5.51	3.82	3.20	4.11	2.72	1.94	2.03	41.40
1900.	3.59	3.20	3.18	3.46	2.90	6.44	3.15	52.46
1901.	1.51	5.66	4.58	3.10	3.70	2.43	9.36	55.70
1902.	2.51	3.87	3.95	4.26	6.36	0.83	7.20	48.58
1903.	10.37	3.88	3.88	2.93	4.43	2.36	3.99	49.58
1904.	3.44	3.84	3.68	5.30	1.78	1.62	2.88	43.06
1905.	4.88	5.39	3.09	6.90	1.81	2.52	3.79	43.58
1906.	5.95	5.52	4.34	2.61	3.95	2.25	4.26	49.08
1907.	3.54	3.03	1.26	9.50	5.68	5.74	4.40	45.74
1908.	1.29	3.85	6.49	1.04	2.13	1.05	3.03	37.83
1909.	3.63	4.25	3.59	3.90	1.70	1.68	3.99	44.50
1910.	4.36	1.52	3.87	2.86	1.40	4.17	2.34	37.85
1911.	2.37	2.53	5.46	3.04	5.24	4.14	3.01	38.73
1912.	0.48	2.65	2.89	2.17	2.53	4.02	4.95	40.19
1913.	0.90	2.37	3.05	4.44	6.02	2.59	2.73	41.22
1914.	2.00	3.92	4.50	0.15	1.88	2.97	3.89	38.54
1915.	3.18	8.60	6.90	1.53	3.05	3.12	5.11	44.65
1916.	6.57	5.66	1.72	4.21	1.42	3.15	2.81	43.43
Totals.	73.42	76.31	82.24	76.25	67.17	73.70	84.77	83.71	70.59	66.85	67.55	83.32	905.88
Average (20 years).	3.67	3.82	4.11	3.81	3.36	3.68	4.24	4.19	3.53	3.34	3.38	4.17	45.30

¹ Means of observations at four places, as follows: January, 1897, to December, 1900, Princeton, Sterling and South Clinton; January, 1901, to December, 1916, Princeton, Jefferson, Sterling and Boylston.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1916.*

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1875,	2.42	3.15	3.74	3.23	3.56	6.24	3.57	5.53	3.43	4.85	4.83	0.94	45.49
1876,	1.83	4.21	7.43	4.20	2.76	2.04	9.13	1.72	4.62	2.24	5.76	3.62	49.56
1877,	3.22	0.74	8.36	3.43	3.70	2.43	2.95	3.68	3.70	8.52	5.80	0.37	44.02
1878,	5.63	5.97	4.69	5.79	0.96	3.88	2.97	6.94	1.29	6.42	7.02	6.37	57.93
1879,	2.48	3.56	5.14	4.72	1.58	3.79	3.93	6.51	1.88	0.81	2.68	4.34	41.42
1880,	3.57	3.98	3.31	3.11	1.84	2.14	6.27	4.01	1.60	3.74	1.78	2.83	38.18
1881,	5.56	4.65	5.73	2.00	3.51	5.39	2.35	1.36	2.62	2.95	4.09	3.96	44.17
1882,	5.95	4.55	2.65	1.82	5.07	1.66	1.77	1.67	8.74	2.07	1.15	2.30	39.40
1883,	2.81	3.87	1.78	1.84	4.19	2.40	2.68	0.73	1.52	5.60	1.81	3.55	32.78
1884,	5.09	6.54	4.72	4.41	3.47	3.44	3.67	4.65	0.85	2.48	2.65	5.17	47.14
1885,	4.71	3.87	1.07	3.60	3.48	2.87	1.43	7.18	1.43	5.09	6.09	2.72	43.54
1886,	6.36	6.28	3.61	2.22	3.00	1.47	3.27	4.10	2.90	3.24	4.64	4.97	46.06
1887,	5.20	4.78	4.90	4.27	1.16	2.65	3.76	5.28	1.32	2.83	2.67	3.88	42.70
1888,	4.15	3.68	6.02	2.43	4.82	2.54	1.41	6.22	8.59	4.99	7.22	5.40	57.47
1889,	5.37	1.65	2.37	3.41	2.95	2.80	8.94	4.18	4.00	4.25	6.29	3.14	49.95
1890,	2.53	3.51	7.73	2.64	5.21	2.03	2.46	3.87	6.00	10.51	1.20	5.31	53.00
1891,	7.02	5.23	6.48	3.91	2.01	3.77	3.39	4.73	2.38	3.83	3.09	3.68	49.52
1892,	5.85	3.14	4.06	0.83	5.58	2.76	4.23	4.44	2.84	1.17	5.80	1.13	41.83
1893,	2.92	8.20	3.67	3.60	6.61	2.38	2.57	5.41	1.74	4.07	2.20	4.86	48.23
1894,	4.09	3.91	1.43	3.42	4.24	1.15	3.26	2.03	2.63	5.34	3.43	4.81	39.74
1895,	4.06	1.39	2.98	5.25	2.02	2.77	5.04	4.15	2.30	10.68	6.63	3.35	50.62
1896,	2.39	7.18	5.24	1.57	2.57	3.22	2.51	2.40	7.72	3.76	3.02	2.12	43.70
1897,	4.00	2.91	3.66	2.82	4.37	4.46	5.44	3.51	2.94	0.47	6.40	5.21	46.19
1898,	6.83	4.49	2.40	4.66	3.22	2.48	4.09	8.17	2.62	6.71	6.93	3.28	55.88
1899,	4.18	4.91	7.01	1.90	1.45	2.51	3.22	1.43	3.95	2.69	2.18	1.78	37.21
1900,	4.96	9.14	6.35	2.58	4.32	2.99	2.42	2.26	3.36	3.83	5.70	2.74	50.65

¹ See note at end of this table.

TABLE No. 6. — *Rainfall in Inches on the Sudbury Watershed,¹ 1875 to 1916* — Concluded.

YEAR.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Totals.
1901,	1.82	1.52	6.57	8.60	7.23	1.38	5.71	4.57	3.30	2.82	2.90	9.69	56.11
1902,	2.52	6.18	5.34	4.13	1.86	2.89	2.94	3.40	4.54	4.44	1.45	6.38	46.07
1903,	3.80	3.95	6.63	2.99	0.93	9.25	2.77	3.67	1.75	4.72	1.56	3.14	45.16
1904,	4.87	3.00	2.72	8.87	2.65	2.80	1.96	3.86	5.80	1.64	1.73	2.92	42.82
1905,	5.26	2.20	3.15	2.72	1.31	5.00	5.47	2.70	6.88	1.54	2.07	4.01	42.31
1906,	2.47	2.92	6.32	2.88	5.66	3.91	3.42	3.02	3.30	3.40	2.69	4.49	44.48
1907,	3.28	2.17	1.91	3.41	3.63	3.53	1.86	1.07	8.76	4.17	6.12	4.47	44.38
1908,	3.60	4.56	3.82	1.88	5.51	0.86	3.71	4.57	0.97	2.55	0.98	3.14	36.15
1909,	3.98	5.79	4.26	4.67	2.43	2.81	1.59	2.93	4.74	1.12	3.38	4.05	41.75
1910,	5.39	5.06	0.85	2.75	1.29	4.68	2.03	2.62	2.49	1.86	4.13	2.49	35.64
1911,	2.88	2.77	3.59	2.81	1.01	2.53	3.19	4.94	2.75	3.69	4.62	3.60	38.38
1912,	2.94	2.77	6.46	4.37	4.55	0.46	3.24	3.05	1.76	2.35	3.04	5.13	40.72
1913,	3.17	2.82	5.75	4.25	3.97	1.98	3.60	3.64	3.77	5.53	2.65	3.18	44.31
1914,	3.85	4.07	4.57	5.10	3.08	1.90	3.44	3.82	0.29	1.60	2.53	3.46	37.71
1915,	6.51	3.58	0.05	2.48	1.74	3.65	8.12	5.87	1.10	2.95	2.79	5.09	43.93
1916,	1.53	5.91	4.16	4.19	3.43	4.77	5.17	2.01	1.80	1.49	2.28	3.22	39.96
Totals,	171.05	174.76	182.68	149.76	137.93	128.66	154.95	161.90	138.19	159.01	156.58	160.79	1876.26
Average (42 years),	4.07	4.16	4.35	3.57	3.28	3.06	3.69	3.85	3.29	3.79	3.73	3.83	44.67

¹ Means of observations at several places, as follows: January, 1875, to March, 1876, inclusive, Lake Cochituate; April and May, 1876, Lake Cochituate, Westborough and Hopkinton; June to November, 1876, inclusive, Lake Cochituate, Southborough, Marlborough, Westborough and Hopkinton; December, 1876, to December, 1882, inclusive, Framingham, Southborough, Marlborough, Westborough and Hopkinton; January, 1883, to December, 1889, inclusive, Framingham and Westborough; January, 1890, to May, 1898, inclusive, Framingham and Ashland Dam; June, 1898, to December, 1916, inclusive, Framingham, Ashland Dam, Cordaville and Sudbury Dam.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1916.*

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.
January,	796,000	1,563,000	2,002,000	796,000	519,000	1,670,000	1,265,000	659,000	1,266,000	1,132,000
February,	931,000	1,635,000	1,990,000	4,054,000	356,000	1,401,000	2,133,000	927,000	452,000	1,027,000
March,	2,760,000	3,088,000	2,770,000	3,722,000	2,718,000	3,992,000	3,423,000	3,008,000	3,004,000	1,860,000
April,	1,632,000	2,027,000	3,376,000	1,580,000	4,986,000	2,159,000	2,238,000	2,984,000	1,617,000	2,109,000
May,	1,163,000	1,390,000	862,000	1,382,000	2,729,000	1,031,000	569,000	1,498,000	445,000	1,533,000
June,	1,181,000	828,000	561,000	578,000	985,000	410,000	2,131,000	762,000	542,000	1,184,000
July,	1,442,000	333,000	354,000	217,000	477,000	292,000	624,000	407,000	365,000	728,000
August,	896,000	1,325,000	236,000	197,000	512,000	297,000	474,000	355,000	321,000	591,000
September,	380,000	676,000	250,000	127,000	320,000	241,000	375,000	404,000	1,228,000	277,000
October,	243,000	1,509,000	245,000	282,000	647,000	950,000	689,000	347,000	367,000	530,000
November,	1,283,000	2,170,000	430,000	875,000	517,000	635,000	634,000	343,000	442,000	749,000
December,	2,275,000	2,061,000	359,000	1,570,000	3,234,000	1,848,000	954,000	440,000	1,018,000	794,000
Average,	1,253,000	1,551,000	1,051,000	1,264,000	1,507,000	1,248,000	1,285,000	1,025,000	926,000	1,043,000
Average, driest six months,	886,000	1,013,000	312,000	377,000	576,000	471,000	626,000	413,000	541,000	613,000

¹ See note at end of this table.

TABLE No. 7. — *Yield of the Wachusett Watershed in Gallons per Day per Square Mile¹ from 1897 to 1916* — Concluded.

MONTH.	1907.	1903.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	Mean for 20 Years, 1897-1916.
January,	1,458,000	1,738,000	592,000	1,846,000	773,000	780,000	1,414,000	990,000	2,062,000	1,315,000	1,237,000
February,	692,000	1,736,000	2,556,000	1,845,000	625,000	927,000	867,000	1,181,000	1,961,000	1,816,000	1,410,000
March,	1,097,000	2,192,000	2,129,000	2,640,000	1,339,000	2,831,000	2,263,000	3,137,000	572,000	1,891,000	2,552,000
April,	1,436,000	1,269,000	2,422,000	1,034,000	1,393,000	2,281,000	2,083,000	2,503,000	926,000	3,300,000	2,173,000
May,	965,000	1,415,000	1,212,000	608,000	461,000	1,797,000	1,038,000	1,699,000	455,000	1,697,000	1,197,000
June,	773,000	403,000	632,000	824,000	351,000	331,000	280,000	317,000	228,000	2,054,000	708,000
July,	335,000	220,000	233,000	62,000	57,000	135,000	19,000	329,000	1,083,000	1,086,000	414,000
August,	87,000	443,000	193,000	186,000	188,000	125,000	60,000	261,000	1,657,000	284,000	434,000
September,	810,000	88,000	208,000	145,000	181,000	89,000	219,000	—12,000	158,000	294,000	327,000
October,	1,382,000	158,000	90,000	68,000	718,000	145,000	678,000	136,000	387,000	140,000	486,000
November,	2,540,000	125,000	363,000	354,000	1,035,000	442,000	660,000	211,000	498,000	321,000	731,000
December,	1,961,000	387,000	537,000	391,000	1,067,000	793,000	955,000	372,000	1,350,000	460,000	1,142,000
Average,	1,180,000	847,000	918,000	828,000	682,000	891,000	879,000	934,000	942,000	1,215,000	1,073,000
Average, driest six months, .	725,000	238,000	270,000	201,000	327,000	210,000	318,000	208,000	666,000	432,000	530,000

¹ The area of the watershed used in making up these records included water surfaces amounting to 2.2 per cent. of the whole area from 1897 to 1902 inclusive, 2.4 per cent. in 1903, 3.6 per cent. in 1904, 4.1 per cent. in 1905, 5.1 per cent. in 1906, 6.0 per cent. in 1907, 7.0 per cent. in 1908, 1909, and 1910, 6.5 per cent. in 1911, 6.8 per cent. in 1912, 6.9 per cent. in 1913, 7.4 per cent. in 1914 and 1915, 7.6 per cent. in 1916.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile, from 1875 to 1916.*

Month.	1875.	1876.	1877.	1878.	1879.	1880.	1881.	1882.	1883.	1884.	1885.
January,	103,030	643,000	658,000	1,810,000	700,000	1,120,000	415,000	1,241,000	335,000	985,000	1,235,000
February,	1,496,000	1,368,000	949,000	2,465,000	1,711,000	1,787,000	1,545,000	2,403,000	1,033,000	2,842,000	1,354,000
March,	1,604,000	4,435,000	4,814,000	3,507,000	2,330,000	1,374,000	4,004,000	2,839,000	1,611,000	3,785,000	1,572,000
April,	3,049,000	3,292,000	2,394,000	1,626,000	3,116,000	1,169,000	1,546,000	867,000	1,350,000	2,853,000	1,815,000
May,	1,188,000	1,138,000	1,391,000	1,394,000	1,114,000	514,000	965,000	1,292,000	937,000	1,030,000	1,336,000
June,	870,000	222,000	597,000	506,000	413,000	175,000	1,338,000	529,000	300,000	416,000	426,000
July,	321,000	183,000	202,000	128,000	157,000	176,000	276,000	86,000	115,000	224,000	62,000
August,	396,000	405,000	121,000	476,000	395,000	119,000	148,000	55,000	79,000	257,000	240,000
September,	207,000	184,000	60,000	161,000	141,000	80,000	197,000	307,000	91,000	44,000	121,000
October,	646,000	234,000	631,000	516,000	71,000	102,000	186,000	299,000	186,000	83,000	336,000
November,	1,302,000	1,088,000	1,418,000	1,693,000	206,000	205,000	395,000	209,000	205,000	175,000	1,177,000
December,	584,000	453,000	1,290,000	3,177,000	463,000	175,000	775,000	315,000	194,000	925,000	1,174,000
Average,	972,000	1,135,000	1,214,000	1,452,000	894,000	578,000	979,000	862,000	533,000	1,120,000	901,000
Average, driest six months, .	574,000	384,000	502,000	532,000	230,000	143,000	330,000	211,000	145,000	200,000	391,000

1 See note at end of this table.

TABLE No. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1916* — Continued.

MONTH.	1886.	1887.	1888.	1889.	1890.	1891.	1892.	1893.	1894.	1895.	1896.
January,	1,461,000	2,589,000	1,053,000	2,782,000	1,254,000	3,018,000	1,870,000	484,000	693,000	1,034,000	1,084,000
February,	4,801,000	2,829,000	1,950,000	1,196,000	1,529,000	3,486,000	943,000	1,542,000	991,000	541,000	2,676,000
March,	2,059,000	2,868,000	3,238,000	1,338,000	3,643,000	4,453,000	1,955,000	3,245,000	2,238,000	2,410,000	3,835,000
April,	1,947,000	2,620,000	2,645,000	1,410,000	1,875,000	2,397,000	871,000	2,125,000	1,640,000	2,515,000	1,494,000
May,	720,000	1,009,000	1,632,000	880,000	1,366,000	583,000	1,259,000	2,883,000	840,000	636,000	360,000
June,	203,000	413,000	421,000	653,000	568,000	413,000	428,000	440,000	419,000	174,000	399,000
July,	116,000	115,000	117,000	634,000	107,000	149,000	214,000	158,000	161,000	231,000	95,000
August,	94,000	214,000	379,000	1,432,000	132,000	163,000	280,000	181,000	209,000	229,000	57,000
September,	117,000	111,000	1,155,000	823,000	457,000	203,000	229,000	108,000	150,000	89,000	338,000
October,	146,000	190,000	1,999,000	1,230,000	2,272,000	210,000	126,000	222,000	374,000	1,379,000	592,000
November,	673,000	368,000	2,758,000	1,941,000	1,215,000	305,000	697,000	319,000	836,000	2,777,000	659,000
December,	1,020,000	643,000	3,043,000	2,241,000	996,000	544,000	485,000	796,000	716,000	1,782,000	657,000
Average,	1,087,000	1,154,000	1,697,000	1,383,000	1,285,000	1,315,000	781,000	1,037,000	770,000	1,152,000	1,019,000
Average, driest six months, .	223,000	234,000	953,000	944,000	747,000	239,000	327,000	237,000	356,000	460,000	314,000

¹ See note at end of this table.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1916* — Continued.

MONTH.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
January,	845,000	1,638,000	2,288,000	794,000	437,000	1,763,000	1,736,000	477,000	1,410,000	1,128,000	1,351,000
February,	1,067,000	3,022,000	1,381,000	3,800,000	300,000	1,674,000	2,279,000	882,080	330,000	1,041,000	624,000
March,	2,565,000	2,604,000	4,205,000	3,654,000	2,755,000	4,199,000	3,454,000	2,909,000	2,497,000	2,409,000	1,658,000
April,	1,515,000	1,829,000	2,521,000	1,350,000	4,204,000	1,865,000	2,261,000	3,204,000	1,643,000	1,949,000	1,607,000
May,	915,000	1,246,000	511,000	1,312,000	2,954,000	743,000	351,000	1,745,000	297,000	1,059,000	888,000
June,	992,000	530,000	66,000	316,000	753,000	303,000	1,987,000	419,000	467,000	707,000	761,000
July,	658,000	231,000	19,000	—18,000	308,000	66,000	445,000	62,000	177,000	398,000	9,000
August,	591,000	1,107,000	—35,000	—34,000	424,000	135,000	307,000	170,000	114,000	180,000	—104,000
September,	182,000	369,000	94,000	65,000	305,000	178,000	130,000	397,000	1,246,000	19,000	541,000
October,	94,000	1,160,000	115,000	186,000	412,000	506,000	492,000	191,000	158,000	301,000	741,000
November,	909,000	1,986,000	304,000	663,000	474,000	444,000	363,000	289,000	279,000	483,000	1,998,000
December,	1,584,000	1,799,000	220,000	1,096,000	2,695,000	1,779,000	582,000	269,000	887,000	659,000	2,032,000
Average,	991,000	1,450,000	973,000	1,082,000	1,342,000	1,140,000	1,190,000	931,000	795,000	860,000	1,010,000
Average, driest six months, .	564,000	777,000	93,000	194,000	445,000	271,000	388,000	228,000	403,000	341,000	471,000

¹ See note at end of this table.

TABLE NO. 8. — *Yield of the Sudbury Watershed in Gallons per Day per Square Mile¹ from 1875 to 1916* — Concluded.

MONTH.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	Mean for 42 Years, 1875-1916.
January,	1,925,000	392,000	1,490,000	519,000	728,000	1,041,000	908,000	1,629,000	942,000	1,190,000
February,	1,536,000	2,286,000	1,849,000	700,000	1,197,000	754,000	1,009,000	1,870,000	1,356,000	1,676,000
March,	2,257,000	1,734,000	1,954,000	1,144,000	3,092,000	2,090,000	3,029,000	593,000	1,820,000	2,711,000
April,	1,117,000	1,721,000	667,000	1,426,000	2,235,000	2,232,000	2,353,000	590,000	3,037,000	2,001,000
May,	1,046,000	1,004,000	277,000	318,000	1,447,000	867,000	1,550,000	255,000	1,439,000	1,034,000
June,	194,000	239,000	516,000	213,000	148,000	149,000	5,000	101,000	1,198,000	485,000
July,	-14,000	-121,000	-102,000	-14,000	-77,000	-62,000	107,000	1,045,000	585,000	184,000
August,	102,000	-45,000	-73,000	20,000	-29,000	-54,000	156,000	1,168,000	78,000	244,000
September,	-82,000	149,000	5,000	76,000	-28,000	88,000	-135,000	38,000	26,000	216,000
October,	47,000	-51,000	-51,000	296,000	-14,000	484,000	-59,000	231,000	-5,000	411,000
November,	71,000	82,000	176,000	593,000	165,000	480,000	97,000	261,000	110,000	735,000
December,	136,000	263,000	221,000	908,000	494,000	732,000	250,000	898,000	315,000	959,000
Average,	694,000	625,000	570,000	514,000	779,000	733,000	772,000	719,000	904,000	985,000
Average, driest six months,	44,000	40,069	29,000	151,000	26,000	180,000	29,000	480,000	186,000	377,000

¹ The area of the Sudbury watershed used in these records included water surfaces amounting to 1.9 per cent. of the whole area from 1875 to 1878, inclusive, and was subsequently increased by the construction of storage reservoirs, to 3.0 per cent. in 1879, 3.4 per cent. in 1885, 3.9 per cent. in 1894, and 6.5 per cent. in 1898. The watershed also contains extensive areas of swampy land, which, though covered with water at times, are not included in the above percentages of water surfaces.

NOTE. — The recorded yields, subsequent to the year 1897, are less accurate than those for previous years, particularly during months of small yield, due to unavoidable inaccuracies in the measurement of large quantities of water received from the Wachusett Reservoir.

TABLE No. 9. — *Wachusett System. — Statistics of Flow of Water, Storage and Rainfall in 1916.*
 [Watershed above dam = 108.84 square miles.]

MONTH.	GALLONS PER DAY.							Rainfall collected (Inches).	Rainfall collected (Inches).	Percentage of Rainfall collected.
	Received from City of Worcester Watershed.	Discharged into Wachusett Aqueduct. ¹	Wasted into River below Dam.	Seepage through the North Dike.	STORAGE. ²		Total Yield of Watershed.			
					Gain.	Loss.				
January,	10,697,000	75,790,000	3,171,000	952,000	73,952,000	—	143,168,000	1.60	2.346	146.7
February,	23,503,000	135,479,000	2,883,000	955,000	81,855,000	—	197,669,000	5.98	3.030	50.7
March,	23,126,000	169,026,000	90,942,000	984,000	—	32,000,000	205,826,000	3.32	3.374	101.5
April,	35,703,000	93,123,000	239,817,000	1,000,000	60,910,000	—	359,147,000	3.65	5.696	156.0
May,	19,987,000	69,510,000	122,232,000	1,000,000	11,961,000	—	184,716,000	3.34	3.028	90.7
June,	21,320,000	91,587,000	155,203,000	1,000,000	—	2,920,000	223,550,000	6.57	3.546	53.9
July,	8,742,000	89,397,000	37,180,000	1,000,000	—	645,000	118,190,000	5.66	1.937	34.2
August,	1,648,000	101,565,000	3,448,000	1,000,000	—	73,484,000	30,881,000	1.72	0.506	29.5
September,	483,000	114,720,000	3,773,000	973,000	—	87,040,000	31,943,000	4.21	0.506	12.0
October,	—	99,287,000	4,174,000	939,000	—	89,174,000	15,226,000	1.42	0.250	17.6
November,	—	100,677,000	4,310,000	903,000	—	70,970,000	34,920,000	3.15	0.554	17.6
December,	—	89,613,000	3,890,000	890,000	—	44,345,000	50,048,000	2.81	0.820	29.2
Total,	—	—	—	—	—	—	—	43.43	25.593	—
Average for year,	12,014,000	102,328,000	55,718,000	967,000	—	14,734,000	132,265,000	—	—	58.9

¹ Including 172,000 gallons per day drawn from aqueduct for the supply of the Westborough State Hospital.

² Aggregate storage in Wachusett Reservoir and in ponds and mill reservoirs.

TABLE NO. 10. — *Sudbury System. — Statistics of Flow of Water, Storage and Rainfall in 1916.*

[Watershed from 1875 to 1878 inclusive=77,764 square miles; in 1879 and 1880=78,238 square miles; and from 1881 to 1916 inclusive=75.2 square miles.]

MONTH.	GALLONS PER DAY.										Rain-fall collected (Inches).	Percent- age of Rain- fall col- lected.
	Water received from Wachusett Reservoir. ¹	Water discharged through Sudbury Aqueduct.	Water discharged through Western Aqueduct.	Water used by Fram- ingham Water Works.	Water di- verted from Watershed by Sewers, etc.	Water wasted into River below Lowest Dam.	STORAGE.		Total Yield of Water- shed.			
							Gain.	Loss.				
January, .	75,597,000	66,045,000	37,220,000	832,000	1,152,000	48,119,000	—	6,919,000	70,852,000	1.53	1.680	109.8
February, .	135,300,000	53,521,000	51,307,000	955,000	1,345,000	150,127,000	—	19,993,000	101,962,000	5.91	2.262	38.2
March, .	168,839,000	46,035,000	59,642,000	836,000	1,655,000	114,110,000	83,390,000	—	136,829,000	4.16	3.245	78.1
April, .	92,947,000	45,270,000	46,803,000	794,000	2,714,000	149,110,000	76,623,000	—	228,367,000	4.19	5.243	125.1
May, .	69,335,000	42,400,000	57,187,000	861,000	2,049,000	76,687,000	—	1,655,000	108,194,000	3.43	2.567	74.9
June, .	91,414,000	41,080,000	57,183,000	867,000	1,900,000	77,480,000	2,967,000	—	90,063,000	4.77	2.068	43.4
July, .	89,232,000	51,268,000	54,358,000	919,000	1,355,000	23,071,000	2,284,000	—	44,023,000	5.17	1.044	20.2
August, .	101,278,000	55,045,000	52,681,000	868,000	1,203,000	7,081,000	—	9,742,000	5,858,000	2.01	0.139	6.9
September, .	114,553,000	53,687,000	53,643,000	813,000	723,000	3,100,000	4,527,000	—	1,940,000	1.80	0.044	2.5
October, .	99,113,000	53,826,000	54,539,000	877,000	742,000	1,668,000	—	12,933,000	—394,000	1.49	—0.009	—0.6
November, .	100,517,000	48,323,000	51,320,000	857,000	787,000	13,156,000	—	5,683,000	8,243,000	2.28	0.189	8.3
December, .	89,461,000	47,600,000	56,361,000	897,000	774,000	21,700,000	—	14,187,000	23,684,000	3.22	0.562	17.4
Total, .	—	—	—	—	—	—	—	—	—	39.96	19.034	—
Av. for year, .	102,145,000	50,360,000	52,699,000	864,000	1,365,000	56,570,000	8,253,000	—	67,996,000	—	—	47.6

¹ Not including 172,000 gallons per day drawn from the Wachusett Aqueduct for the supply of the Westborough State Hospital, which were not discharged into Sudbury Reservoir.

TABLE No. 11. — *Cochituate System. — Statistics of Flow of Water, Storage and Rainfall in 1916.*
 [Watershed of lake=17.58 square miles.¹]

MONTH.	GALLONS PER DAY.						Rainfall (Inches).	Rainfall collected (Inches).	Percent- age of Rainfall collected.
	Water discharged through Cochituate Aqueduct.	Water di- verted from Watershed by Sewers, etc.	Water wasted at Outlet of Lake.	STORAGE.		Total Yield of Watershed.			
				Gain.	Loss.				
January,	—	1,152,000	22,251,000	—	4,528,000	18,877,000	1.52	1.91	126.0
February,	—	1,317,000	31,970,000	—	2,945,000	30,348,000	5.66	2.88	50.9
March,	—	1,926,000	29,593,000	7,668,000	—	39,187,000	4.62	3.98	86.1
April,	—	2,400,000	50,570,000	—	6,407,000	46,653,000	4.12	4.58	111.2
May,	—	1,736,000	32,448,000	—	5,410,000	28,774,000	3.20	2.92	91.2
June,	—	1,433,000	24,697,000	—	150,000	25,980,000	5.45	2.55	46.8
July,	—	1,013,000	10,471,000	2,777,000	—	14,261,000	3.89	1.45	37.2
August,	—	726,000	—	3,042,000	—	3,768,000	1.75	0.38	21.8
September,	—	620,000	—	450,000	—	1,070,000	1.30	0.10	8.1
October,	—	503,000	—	668,000	—	1,171,000	1.28	0.12	9.3
November,	—	503,000	—	1,900,000	—	2,403,000	2.18	0.24	10.8
December,	—	464,000	—	4,426,000	—	4,890,000	3.18	0.50	15.6
Total,	—	—	—	—	—	—	38.15	21.61	—
Average for year,	—	1,155,000	16,730,000	154,000	—	18,039,000	—	—	56.6

¹ Not including the watersheds of Dudley and Dug ponds.

TABLE NO. 12. — *Elevations of Water Surfaces of Reservoirs above Boston City Base at the Beginning of Each Month.*

DATE.	Chestnut Hill Reservoir. Ordinary High Water = 134.00.	Lake Cochituate. High Water = 144.36.	Farm Pond. High Water = 159.25.	Spot Pond. High Water = 163.00.	Weston Reservoir. High Water = 200.00.	FRAMINGHAM RESERVOIR.			Ashland Reservoir. Flash Boards 225.23.	Sudbury Reservoir. Flash Boards 259.97.	Hopkinton Reservoir. Flash Boards 305.00.	Whitchall Reservoir. Ordinary High Water = 337.91.	Wachusett Reservoir. Ordinary High Water = 395.00.
						No. 1. Flash Boards 169.32.	No. 2. Flash Boards 177.12.	No. 3. Flash Boards 186.50.					
Jan. 1, 1916, .	133.89	142.93	157.87	162.99	199.80	167.89	176.19	184.48	224.53	249.53	304.24	337.29	391.05
Feb. 1, 1916, .	133.83	142.25	157.92	162.80	198.44	167.90	176.20	184.83	224.56	248.93	304.27	336.91	392.81
Mar. 1, 1916, .	133.23	141.91	158.33	162.77	198.54	168.14	176.43	184.48	223.96	247.31	303.14	336.65	394.57
Apr. 1, 1916, .	133.07	142.98	158.62	162.63	199.53	168.40	176.63	182.54	223.33	255.52	303.42	336.54	393.83
May 1, 1916, .	132.95	142.14	158.84	162.31	199.54	168.26	176.37	186.33	225.21	259.59	304.95	337.51	395.19
June 1, 1916, .	133.01	141.50	158.72	162.34	199.44	167.84	176.70	185.51	225.17	259.55	304.98	337.73	395.56
July 1, 1916, .	133.09	141.48	158.69	162.18	199.50	167.75	176.64	185.56	225.19	259.69	305.04	337.88	395.51
Aug. 1, 1916, .	133.41	141.66	158.48	162.48	200.04	169.46	177.27	184.70	225.25	259.80	305.01	337.87	395.48
Sept. 1, 1916, .	133.46	142.12	158.01	162.52	199.89	169.39	177.19	181.76	225.23	259.25	304.96	337.66	394.02
Oct. 1, 1916, .	133.28	142.19	157.63	162.49	198.94	169.27	177.15	184.43	225.15	259.82	304.77	337.49	392.02
Nov. 1, 1916, .	133.58	142.28	157.37	162.67	199.96	169.35	177.18	185.45	225.13	258.74	304.63	337.42	389.95
Dec. 1, 1916, .	133.63	142.55	157.30	162.78	196.68	167.88	176.09	184.42	224.37	259.00	304.14	337.39	388.23
Jan. 1, 1917, .	133.24	143.23	157.39	162.41	197.57	167.70	176.02	183.53	224.28	258.49	304.07	336.65	387.11

TABLE NO. 13. — *Sources from which and Periods during which Water has been drawn for the Supply of the Metropolitan Water District.**From Wachusett Reservoir into the Wachusett Aqueduct.*

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	27	270	25	2,349.5
February,	27	440	30	3,928.9
March,	29	466	10	5,239.8
April,	25	286	41	2,793.7
May,	26	239	10	2,154.8
June,	27	321	16	2,747.6
July,	29	392	35	2,771.3
August,	27	414	—	3,144.8
September,	26	384	8	3,441.6
October,	28	434	43	3,077.9
November,	25	274	22	3,020.3
December,	25	262	41	2,778.0
Totals,	321	4,186	41	37,448.2

Total actual time, 174.45 days.

Total quantity drawn, 37,448,200,000 gallons.

From Sudbury Reservoir through the Weston Aqueduct to Weston Reservoir.

MONTH.	Number of Days during which Water was flowing.	ACTUAL TIME.		Million Gallons drawn.
		Hours.	Minutes.	
January,	31	713	30	1,153.8
February,	29	661	—	1,487.9
March,	31	744	—	1,848.9
April,	26	603	—	1,404.1
May,	31	738	—	1,772.8
June,	30	720	—	1,715.5
July,	31	744	—	1,685.1
August,	31	744	—	1,633.1
September,	28	549	20	1,609.3
October,	31	735	30	1,690.7
November,	29	533	25	1,539.6
December,	25	367	6	1,747.2
Totals,	353	7,852	51	19,288.0

Total actual time, 327.20 days.

Total quantity drawn, 19,288,000,000 gallons.

TABLE No. 13 — *Concluded.**From Framingham Reservoir No. 3 through the Sudbury Aqueduct to Chestnut Hill Reservoir.*

MONTH.	Number of Days during which Water was flowing.	Actual Time (Hours).	Million Gallons drawn.
January,	31	744	2,047.4
February,	29	696	1,552.1
March,	31	744	1,427.1
April,	30	720	1,358.1
May,	31	744	1,314.4
June,	30	720	1,232.4
July,	31	739	1,589.3
August,	31	744	1,706.4
September,	30	720	1,610.6
October,	31	744	1,668.6
November,	30	720	1,449.7
December,	31	744	1,475.6
Totals,	366	8,779	18,431.7

Total actual time, 366 days.

Total quantity drawn, 18,431,700,000 gallons.

TABLE No. 14. — *Average Daily Quantity of Water flowing through Aqueducts in 1916 by Months.*¹

MONTH.	Wachusett Aqueduct into Sudbury Reservoir (Gallons).	Weston Aqueduct into Metropolitan District (Gallons).	Sudbury Aqueduct into Chestnut Hill Reservoir (Gallons).	Cochituate Aqueduct into Chestnut Hill Reservoir (Gallons).
January,	75,597,000	37,220,000	66,045,000	—
February,	135,300,000	51,307,000	53,521,000	—
March,	168,839,000	59,642,000	46,035,000	—
April,	92,947,000	46,803,000	45,270,000	—
May,	69,335,000	57,187,000	42,400,000	—
June,	91,414,000	57,183,000	41,080,000	—
July,	89,232,000	54,358,000	51,268,000	—
August,	101,278,000	52,681,000	55,045,000	—
September,	114,553,000	53,643,000	53,687,000	—
October,	99,113,000	54,539,000	53,826,000	—
November,	100,517,000	51,320,000	48,323,000	—
December,	89,461,000	56,361,000	47,600,000	—
Average,	102,145,000	52,699,000	50,360,000	—

¹ Not including quantities wasted while cleaning and repairing aqueducts.

TABLE No. 15. — Statement of Operation of Engines Nos. 1 and 2 at Chestnut Hill Pumping Station No. 1 for the Year 1916.

[3 per cent. allowed for slip.]

MONTH.	ENGINE No. 1.		ENGINE No. 2.		Total Quantity pumped (Million Gallons).	Coal consumed in Pumping (Pounds).	Coal used in Banking (Pounds).	Ashes and Clinker from Coal used in Pumping (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal used in Pumping.	AVERAGE LIFT (FEET).		Duty in Foot-pounds per 100 Pounds of Coal used in Pumping; corrected for Slip.	Duty in Foot-pounds per 100 Pounds of Coal used in Pumping, on Basis of Plunger Displacement.
	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).							Engine No. 1.	Engine No. 2.		
January,	Hrs. Min. 51 05	17.88	Hrs. Min. 1	1	17.88	31,380	54,730	2,190	6.9	569.79	134.95	1	64,050,000	66,040,000
February,	59 25	21.45	1	1	21.45	33,380	50,105	2,350	7.1	642.60	135.61	1	72,590,000	74,850,000
March,	1	1	1	1	1	1	72,305	1	1	1	1	1	1	1
April,	1	1	1	1	1	1	30,635	1	1	1	1	1	1	1
May,	1	1	1	1	1	1	27,985	1	1	1	1	1	1	1
June,	1	1	1	1	1	1	6,085	1	1	1	1	1	1	1
July,	1	1	1	1	1	1	11,895	1	1	1	1	1	1	1
August,	10 30	4.03	1	1	4.03	5,600	5,465	509	9.1	719.64	129.44	1	77,590,000	80,000,000
September,	1	1	1	1	1	1	3,960	1	1	1	1	1	1	1
October,	1	1	1	1	1	1	11,260	1	1	1	1	1	1	1
November,	66 20	23.19	1	1	23.19	72,495	18,845	6,887	9.5	319.88	136.18	1	36,290,000	37,420,000
December,	56 00	19.94	231 25	69.60	89.54	258,230	1	23,499	9.1	346.75	136.43	133.31	38,710,000	39,910,000
Total,	243 20	86.49	231 25	69.60	156.09	401,085	293,360	35,435	1	1	1	1	43,610,000	44,970,000
Average,	1	1	1	1	1	1	1	1	8.8	389.17	135.53	133.31	1	1

TABLE No. 18. — Statement of Operation of Engines Nos. 5, 6 and 7 at Chestnut Hill Pumping Station No. 2 for the Year 1916.
[2 per cent. allowed for slip.]

MONTH.	ENGINE No. 5.		ENGINE No. 6.		ENGINE No. 7.		Total Quantity pumped (Million Gallons).	Daily Average Quantity pumped (Million Gallons).	Total Coal consumed (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Ton of Coal, no Deduction for Heating or Lighting.	AVERAGE LIFT (FEET).			Duty in Foot-pounds per 100 Pounds of Coal, corrected for Heating or Lighting.	Duty in Foot-pounds per 100 Pounds of Coal, on Basis of Plunger Displacement; no Deduction for Heating or Lighting.
	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).										
January, . . .	Hrs.Min. 742 30	834.98	Hrs.Min. 231 00	233.71	Hrs.Min. — —	—	1,068.69	34.474	412,685	10.3	2,589.60	41.66	43.03	—	90,510,000	92,370,000
February, . . .	154 35	176.70	28 05	25.88	396 45	402.87	605.45	20.878	395,160	14.4	1,532.16	39.23	39.26	31.10	43,170,000	44,050,000
March, . . .	—	—	—	—	405 00	388.68	388.68	12.538	257,560	10.9	1,509.09	—	—	32.48	40,830,000	41,670,000
April, . . .	—	—	102 10	105.88	316 55	312.20	417.58	13.919	203,750	13.0	2,049.47	—	34.29	33.26	57,230,000	58,400,000
May, . . .	—	—	9 15	12.06	371 20	307.40	319.46	10.305	198,080	17.5	1,612.78	—	36.67	34.94	47,030,000	47,990,000
June, . . .	—	—	—	—	323 05	267.68	267.68	8.923	249,105	18.5	1,074.57	—	—	35.08	31,400,000	32,040,000
July, . . .	—	—	—	—	523 55	539.40	539.40	17.400	219,530	11.5	2,457.07	—	—	33.85	69,280,000	70,700,000
August, . . .	—	—	—	—	612 30	659.39	659.39	21.271	252,115	11.2	2,615.43	—	—	33.80	73,640,000	75,150,000
September, . . .	—	—	45 55	51.30	506 20	546.13	597.43	19.914	250,785	10.7	2,382.24	—	34.64	33.55	66,760,000	68,130,000
October, . . .	—	—	—	—	482 55	559.26	559.26	18.041	246,015	12.5	2,273.28	—	—	34.05	64,480,000	65,800,000
November, . . .	89 50	91.39	—	—	350 20	372.28	463.67	15.456	244,650	14.4	1,895.24	34.97	—	34.09	54,090,000	55,200,000
December, . . .	23 25	23.40	25	.21	408 55	416.65	440.26	14.202	287,860	14.9	1,529.42	35.43	—	34.15	43,570,000	44,460,000
Total, . . .	1,010 20	1,126.47	416 50	428.54	4,728 00	4,771.94	6,326.95	—	3,217,295	—	—	—	—	—	—	—
Average, . . .	—	—	—	—	—	—	—	17.287	—	13.2	1,966.54	40.61	39.45	33.63	60,360,000	61,600,000

TABLE No. 19. — Statement of Operation of Engine No. 12 at Chestnut Hill Pumping Station No. 2 for the Year 1916.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal; no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, corrected for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement; no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	739	40	1,072.01	714,765	79,535	11.1	1,499.81	123.11	153,810,000	156,930,000
February,	692	45	1,008.02	574,615	80,425	14.0	1,754.25	123.08	179,860,000	183,510,000
March,	740	00	1,093.11	714,385	83,510	11.7	1,530.14	125.56	160,040,000	163,290,000
April,	716	50	1,004.26	725,470	96,145	13.3	1,384.29	124.69	143,780,000	146,700,000
May,	737	30	1,043.47	711,470	79,985	11.2	1,466.64	124.79	152,460,000	155,550,000
June,	720	00	1,005.60	612,815	68,035	11.1	1,640.95	124.71	170,470,000	173,930,000
July,	744	00	1,052.69	762,805	86,045	11.3	1,380.03	124.41	143,020,000	145,920,000
August,	715	00	1,037.10	724,010	78,320	10.8	1,432.44	125.13	149,310,000	152,340,000
September,	720	00	1,043.66	709,840	81,820	11.5	1,470.27	124.72	152,750,000	155,850,000
October,	744	00	1,088.01	734,705	88,000	12.0	1,480.88	125.14	154,370,000	157,500,000
November,	456	50	636.14	432,310	56,395	13.0	1,471.49	124.55	152,670,000	155,770,000
December,	-	-	-	-	-	-	-	-	-	-
Total,	7,726	35	11,084.07	7,417,190	878,215	-	-	-	-	-
Average,	-	-	-	-	-	11.8	1,494.38	124.54	155,030,000	158,180,000

TABLE No. 21. — Statement of Operation of Engine No. 9 at Spot Pond Pumping Station for the Year 1916.

[2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, corrected for Slip; no Deduction for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement; no Deduction for Heating or Lighting.	SUMMARY OF ENGINES NOS. 8 AND 9.	
										Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
January,	Hrs. Min. 199 40	167.51	154,298	18,737	12.1	1,085.63	127.13	114,970,000	117,300,000	204.15	6.585
February,	231 30	192.36	172,566	17,595	10.2	1,112.13	128.45	119,000,000	121,420,000	192.36	6.633
March,	246 10	206.88	182,555	17,955	9.8	1,133.25	128.42	121,230,000	123,690,000	206.88	6.674
April,	232 35	195.42	185,575	24,775	13.4	1,053.05	128.26	112,510,000	114,790,000	195.42	6.514
May,	252 10	211.17	190,774	23,395	12.3	1,106.91	129.25	119,180,000	121,600,000	215.89	6.964
June,	257 10	214.60	192,999	23,031	12.2	1,111.92	129.31	119,770,000	122,200,000	214.60	7.153
July,	288 55	241.70	215,216	26,420	12.3	1,123.06	129.51	121,160,000	123,620,000	241.70	7.707
August,	295 35	250.76	220,362	32,055	14.5	1,137.95	128.97	122,250,000	124,730,000	250.76	8.089
September,	276 40	233.11	210,946	34,730	16.5	1,106.64	129.30	119,190,000	121,610,000	233.11	7.770
October,	269 25	224.22	212,510	31,745	14.9	1,055.10	130.05	114,300,000	116,620,000	224.22	7.233
November,	254 35	211.74	204,560	31,505	15.4	1,035.10	130.19	112,250,000	114,530,000	211.74	7.058
December,	255 40	209.99	206,046	29,248	14.2	1,019.14	131.44	111,590,000	113,860,000	209.99	6.774
Total,	3,060 05	2,559.46	2,348,507	311,791	-	-	-	-	-	2,600.82	-
Average,	- 4	-	-	-	13.3	1,089.82	129.24	117,330,000	119,710,000	-	7.106

TABLE No. 22. — *Statement of Operation of Engine No. 10 at Arlington Pumping Station for the Year 1916.*
 [2 per cent. allowed for slip.]

MONTH.	Total Pumping Time.		Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal, no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, corrected for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement, no Deduction for Heating or Lighting.
	Hrs.	Min.								
January,	476	15	19.16	83,620	8,722	10.4	229.13	279.99	53,440,000	54,360,000
February,	458	15	18.29	79,005	8,313	10.5	231.50	279.91	53,980,000	54,910,000
March,	188	30	7.47	33,025	3,466	10.5	226.19	279.43	52,650,000	53,560,000
April,	366	15	15.52	74,495	8,894	11.9	208.34	281.44	48,840,000	49,680,000
May,	513	15	23.26	97,125	11,309	11.6	239.49	282.00	56,260,000	57,230,000
June,	508	15	23.58	91,650	10,543	11.5	257.30	280.77	60,180,000	61,220,000
July,	546	30	26.03	99,350	11,760	11.8	262.00	282.64	61,690,000	62,760,000
August,	637	00	32.47	121,020	15,933	13.2	268.30	284.74	63,640,000	64,740,000
September,	592	20	29.96	117,675	15,156	12.9	254.60	283.50	60,130,000	61,170,000
October,	551	30	27.66	113,480	15,562	13.7	243.74	283.05	57,470,000	58,460,000
November,	508	15	23.71	102,805	13,324	13.0	230.63	280.46	53,880,000	54,810,000
December,	518	00	23.74	114,555	16,460	14.4	207.24	281.34	48,570,000	49,410,000
Total,	5,864	20	270.85	1,127,805	139,442	-	-	-	-	-
Average,						12.4	240.16	281.98	56,410,000	57,390,000

TABLE No. 23. — Statement of Operation of Engine No. 11 at Arlington Pumping Station for the Year 1916.

[4 per cent. allowed for slip.]

MONTH.	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).	Coal consumed (Pounds).	Ashes and Clinker (Pounds).	Per Cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal; no Deduction for Heating or Lighting.	Average Lift (Feet).	Duty in Foot-pounds per 100 Pounds of Coal, corrected for Slip; no Deduction for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement; no Deduction for Heating or Lighting.	SUMMARY OF ENGINES Nos. 10 AND 11.	
										Total Quantity pumped, corrected for Slip (Million Gallons).	Daily Average Quantity pumped (Million Gallons).
January, .	Hrs. Min. 20 45	.58	4,305	531	12.3	134.73	270.37	30,340,000	31,750,000	19.74	.637
February, .	-	-	-	-	-	-	-	-	-	18.29	.631
March, .	449 00	12.98	86,215	11,189	13.0	150.55	277.46	34,800,000	36,420,000	20.45	.660
April, .	141 30	4.52	29,405	4,628	15.7	133.72	277.90	35,580,000	37,230,000	20.04	.668
May, .	-	-	-	-	-	-	-	-	-	23.26	.750
June, .	-	-	-	-	-	-	-	-	-	23.58	.786
July, .	45 45	1.79	10,980	1,214	11.0	162.82	278.00	37,750,000	39,510,000	27.82	.897
August, .	12 00	.33	2,460	415	16.9	134.15	307.46	34,360,000	35,960,000	32.80	1.058
September, .	-	-	-	-	-	-	-	-	-	29.96	.999
October, .	28 30	.83	5,385	917	17.0	154.13	285.05	36,590,000	38,290,000	28.49	.919
November, .	-	-	-	-	-	-	-	-	-	23.71	.790
December, .	-	-	-	-	-	-	-	-	-	23.74	.766
Total,	697 30	21.03	138,750	18,894	-	-	-	-	-	291.88	-
Average, .	-	-	-	-	13.6	151.57	278.17	35,120,000	36,750,000	-	.797

TABLE No. 24. — Statement of Operation of Engines Nos. 13 and 14 at Hyde Park Pumping Station for the Year 1916.

[2 per cent. allowed for slip.]

MONTH.	ENGINE No. 13.		ENGINE No. 14.		Total Quantity pumped (Million Gallons).	Total coal consumed (Tons).	Total Ashes and Clinker (Pounds).	Per cent. of Ashes and Clinker.	Gallons pumped per Pound of Coal: no Deduction for Heating or Lighting.	AVERAGE LIFT (FEET).		Duty in Foot-pounds per 100 Pounds of Coal, corrected for Slip; no Deduction for Heating or Lighting.	Duty in Foot-pounds on Basis of Plunger Displacement; no Deduction for Heating or Lighting.
	Total Pumping Time.	Quantity pumped (Million Gallons).	Total Pumping Time.	Quantity pumped, corrected for Slip (Million Gallons).						Engine No. 13.	Engine No. 14.		
January,	Hrs. Min. 502 20	17.82	Hrs. Min. 72 50	2.69	20.51	43,103	4,755	11.0	475.84	123.45	122.76	48,890,000	49,940,000
February,	560 40	19.12	- - -	-	19.12	43,100	6,608	15.3	443.62	124.57	-	46,030,000	47,020,000
March,	381 35	13.48	202 20	7.53	21.01	54,478	8,547	15.7	385.66	123.46	122.49	39,550,000	40,400,000
April,	515 25	21.84	- - -	-	21.84	51,596	9,894	19.2	423.29	127.15	-	44,830,000	45,790,000
May,	297 30	20.85	1 00	.04	20.89	48,738	9,008	18.5	428.62	131.70	128.50	47,020,000	48,030,000
June,	238 55	19.81	- - -	-	19.81	42,728	7,092	16.6	463.73	134.37	-	51,910,000	53,030,000
July,	220 00	18.22	- - -	-	18.22	44,004	8,410	19.1	413.49	135.28	-	46,600,000	47,600,000
August,	220 25	15.70	50 10	3.53	19.23	46,698	9,437	20.2	411.79	133.62	134.92	45,910,000	46,900,000
September,	148 15	9.57	136 55	9.48	19.05	46,576	7,579	16.3	409.01	132.84	134.71	45,580,000	46,560,000
October,	286 00	20.74	11 15	.67	21.41	47,786	8,078	16.9	448.04	132.20	132.10	49,330,000	50,390,000
November,	182 50	16.51	37 25	3.16	19.67	43,846	7,315	16.7	448.62	136.85	136.42	51,130,000	52,230,000
December,	- - -	-	220 05	18.95	18.95	48,040	7,257	15.1	394.46	-	137.48	45,170,000	46,140,000
Total,	3,553 55	193.66	732 00	46.05	239.71	560,753	93,080	-	-	-	-	-	-
Average,	- - -	-	- - -	-	-	-	-	16.8	427.48	130.47	133.34	46,650,000	47,650,000

TABLE No. 25. — (Meter Basis.) Average Daily Consumption of Water by Districts in the Cities and Towns supplied by the Metropolitan Water Works in 1916. (For Consumption of Water in Whole Metropolitan Water District, see Table No. 27.)

Month.	Southern Low Service.	Northern Low Service.	Southern High Service.	Northern High Service.	Southern Extra High Service.	Northern Extra High Service.	Total District supplied (Gallons).	Estimated Population.	Consumption per Inhabitant (Gallons).
	Boston, excluding East Boston and Charlestown (Gallons).	Portions of Charlestown, Somerville, Chelsea, Everett, Malden, Medford, East Boston and Arlington (Gallons).	Quincy, Watertown, and Portions of Boston, Belmont and Milton (Gallons).	Revere, Winthrop, Swampscott, Nahant, Stoneham, Melrose, and Portions of Boston, Chelsea, Everett, Malden, Somerville (Gallons).	Portions of Boston and Milton (Gallons).	Lexington and Portions of Arlington and Belmont (Gallons).			
January, . . .	44,794,500	21,451,800	34,666,300	6,961,500	648,200	638,500	109,160,800	1,177,410	93
February, . . .	45,717,200	22,759,100	35,057,700	7,090,300	654,700	630,600	111,909,600	1,179,550	95
March, . . .	44,264,500	21,865,700	34,820,100	7,246,200	646,300	659,600	109,502,400	1,181,680	93
April, . . .	38,785,500	20,027,100	32,985,100	7,056,400	711,100	670,000	100,235,200	1,183,820	85
May, . . .	40,097,300	20,698,000	33,253,700	7,539,100	699,100	746,200	103,033,400	1,185,950	87
June, . . .	40,292,700	20,502,000	32,917,600	7,797,600	699,400	783,000	102,992,300	1,188,090	87
July, . . .	41,459,200	21,239,100	33,422,500	8,448,200	624,500	900,100	106,093,600	1,190,220	89
August, . . .	42,239,400	21,917,600	34,295,900	8,727,800	643,300	1,063,200	108,917,200	1,192,360	91
September, . . .	41,127,200	21,203,400	34,406,600	8,308,300	642,800	1,007,400	106,695,700	1,194,490	89
October, . . .	41,796,600	21,522,900	34,024,700	7,772,800	664,300	914,300	106,695,600	1,196,620	89
November, . . .	41,507,700	20,928,200	32,131,700	7,380,900	651,700	804,700	103,404,900	1,198,760	86
December, . . .	43,524,400	21,921,100	33,210,300	7,356,800	588,300	782,900	107,384,300	1,200,900	89
For the year, . . .	42,132,900	21,338,400	33,766,200	7,643,600	656,000	800,700	106,337,800	1,190,220	89

In addition to the above quantities the United States Government Reservation on Peddock's Island was supplied with 25,292,000 gallons, equivalent to a daily average rate of 69,100 gallons, and a part of Saugus with 7,022,000 gallons, equivalent to a daily average rate of 19,200 gallons.

TABLE No. 26. — (Meter Basis.) *Average Daily Consumption of Water in Cities and Towns supplied by the Metropolitan Water Works in 1916.*

City or town,	BOSTON.		SOMERVILLE.		MALDEN.		CHELSEA.		EVERETT.		QUINCY.		MEDFORD.	
	Population,	GALLONS.	89,190.	GALLONS.	50,160.	GALLONS.	45,020.	GALLONS.	38,870.	GALLONS.	42,030.	GALLONS.	32,080.	GALLONS.
MONTH.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.	Per Day.	Per Capita.
January,	84,497,700	112	6,228,300	71	2,222,400	45	3,080,600	69	2,957,200	77	2,395,300	58	1,337,100	43
February,	86,245,900	114	6,509,400	74	2,283,500	46	3,304,100	74	3,141,300	82	2,430,100	58	1,376,600	44
March,	84,012,900	111	6,217,000	70	2,333,500	48	3,167,900	71	3,103,600	80	2,413,700	58	1,461,100	46
April,	75,988,000	100	5,628,700	63	2,321,800	47	2,941,500	66	2,847,500	74	2,411,300	58	1,389,300	44
May,	77,511,100	102	5,873,800	66	2,413,000	48	2,970,000	66	2,910,100	75	2,585,700	62	1,510,000	47
June,	77,556,200	102	5,904,800	66	2,457,100	49	2,851,600	63	2,745,900	71	2,533,900	60	1,447,900	45
July,	79,830,700	104	6,031,900	68	2,498,400	50	2,981,400	66	2,792,600	72	2,685,500	64	1,483,500	46
August,	80,701,800	106	6,440,900	72	2,662,400	53	3,145,000	70	2,804,700	72	2,713,000	64	1,637,300	51
September,	79,352,800	104	6,202,600	69	2,713,600	54	3,121,700	69	2,800,500	72	2,701,700	64	1,543,100	48
October,	79,874,700	104	6,335,100	71	2,693,600	53	3,125,900	69	2,869,200	73	2,508,400	59	1,538,300	47
November,	77,838,700	101	6,247,000	70	2,471,400	49	3,049,600	67	2,820,500	72	2,314,900	55	1,530,600	47
December,	81,379,300	106	6,580,700	73	2,389,300	47	3,116,200	68	2,903,800	74	2,293,300	54	1,580,900	48
For the year,	80,358,800	105	6,183,600	69	2,460,200	49	3,070,900	68	2,891,400	74	2,499,400	59	1,487,000	46

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc. — Continued.*

City or town, Population,	MONTH.	MELROSE.			REVERE.			WATERTOWN.			ARLINGTON.			MILTON.			WINTHROP.		
		17,260.			26,790.			17,280.			15,670.			8,850.			13,470.		
		GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	740,700	43	.	1,445,500	55	.	1,000,100	59	.	765,600	50	.	363,500	42	.	609,300	46	.
February,	730,900	43	.	1,535,200	59	.	1,021,200	60	.	752,900	49	.	379,600	43	.	602,600	46	.
March,	755,100	44	.	1,499,900	57	.	1,033,600	61	.	767,700	50	.	399,900	45	.	642,000	48	.
April,	745,500	43	.	1,395,700	53	.	1,032,400	60	.	800,300	52	.	427,600	49	.	659,400	49	.
May,	793,100	46	.	1,522,200	57	.	1,098,700	64	.	891,600	57	.	447,900	51	.	672,900	50	.
June,	788,900	46	.	1,621,500	61	.	1,112,900	65	.	894,300	57	.	357,600	40	.	723,500	54	.
July,	779,400	45	.	1,904,300	71	.	1,086,900	63	.	1,042,300	67	.	307,400	35	.	869,000	65	.
August,	848,500	49	.	1,940,800	72	.	1,133,900	65	.	1,242,500	79	.	324,500	37	.	948,700	70	.
September,	840,100	49	.	1,760,100	65	.	1,160,200	67	.	1,162,800	74	.	361,200	41	.	809,900	60	.
October,	812,800	47	.	1,530,100	56	.	1,268,500	73	.	1,079,100	68	.	384,400	43	.	689,600	51	.
November,	780,500	45	.	1,449,700	53	.	1,219,000	70	.	874,000	55	.	370,900	42	.	650,600	48	.
December,	764,100	44	.	1,478,200	54	.	1,332,900	76	.	868,300	55	.	332,100	37	.	609,900	44	.
For the year,	781,800	45	.	1,591,200	59	.	1,125,500	65	.	929,400	59	.	371,300	42	.	707,800	53	.

TABLE No. 26. — *Average Daily Consumption of Water in Cities and Towns, etc.* — Concluded.

City or town,	MONTH.	STONEHAM.			BELMONT.			LEXINGTON.			NAHANT.			SWAMPSCOTT.			METROPOLITAN DISTRICT.		
		7,590.			8,560.			5,680.			1,440.			7,580.			1,190,220.		
		GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.			GALLONS.		
		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.		Per Day.	Per Capita.	
January,	387,700	51	.	374,000	45	.	328,300	58	.	68,900	49	.	358,600	48	.	109,160,800	93	.
February,	413,500	55	.	394,900	47	.	337,500	60	.	69,900	49	.	372,500	50 j	.	111,909,600	95	.
March,	430,300	57	.	417,700	49	.	318,100	62	.	81,000	57	.	367,400	49	.	109,502,400	93	.
April,	388,300	51	.	430,500	51	.	362,400	64	.	103,100	72	.	361,900	48	.	100,235,200	85	.
May,	410,900	54	.	453,300	53	.	389,000	69	.	151,000	106	.	429,100	57	.	103,033,400	87	.
June,	416,500	55	.	442,500	52	.	403,000	71	.	237,600	166	.	496,600	66	.	102,992,300	87	.
July,	440,200	58	.	462,100	54	.	414,900	73	.	330,700	230	.	602,100	79	.	106,093,600	89	.
August,	423,700	56	.	545,100	63	.	460,400	81	.	304,300	211	.	639,700	84	.	108,917,200	91	.
September,	429,400	56	.	515,900	60	.	435,400	76	.	231,800	160	.	552,900	73	.	106,695,700	89	.
October,	463,400	62	.	492,400	57	.	425,600	75	.	149,300	103	.	450,300	59	.	106,695,600	89	.
November,	498,200	65	.	437,100	50	.	393,500	69	.	91,400	63	.	367,300	48	.	103,401,900	86	.
December,	545,700	72	.	405,900	47	.	373,000	65	.	84,300	58	.	341,400	45	.	107,384,300	89	.
For the year,	437,900	58	.	447,800	52	.	389,400	69	.	159,000	110	.	445,400	59	.	106,337,800	89	.

TABLE No. 27. — (Pump Basis.) Consumption of Water in the Metropolitan Water District, as constituted in the Year 1916, and a Small Section of the Town of Saugus, from 1893 to 1916.

[Gallons per day.]

MONTH.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
January,	75,209,000	67,506,000	68,925,000	82,946,000	85,366,000	83,880,000	96,442,000	100,055,000	111,275,000	118,435,000	125,176,000	137,771,000
February,	71,900,000	68,944,000	80,375,000	87,021,000	83,967,000	87,475,000	103,454,000	98,945,000	117,497,000	117,268,000	122,728,000	143,222,000
March,	67,633,000	62,710,000	69,543,000	86,111,000	82,751,000	85,468,000	90,200,000	97,753,000	105,509,000	108,461,000	111,977,000	123,334,000
April,	62,309,000	57,715,000	62,909,000	77,529,000	79,914,000	76,574,000	86,491,000	89,497,000	93,317,000	103,153,000	107,179,000	108,688,000
May,	61,025,000	60,676,000	65,104,000	73,402,000	76,772,000	76,677,000	89,448,000	87,780,000	95,567,000	106,692,000	111,589,000	111,715,000
June,	63,374,000	68,329,000	69,905,000	77,639,000	77,952,000	83,463,000	97,691,000	98,581,000	103,420,000	110,002,000	105,590,000	111,209,000
July,	69,343,000	73,642,000	69,667,000	80,000,000	85,525,000	89,228,000	96,821,000	107,786,000	106,905,000	108,340,000	107,562,000	113,584,000
August,	66,983,000	67,995,000	72,233,000	78,537,000	84,103,000	87,558,000	92,072,000	102,717,000	102,815,000	107,045,000	103,570,000	112,836,000
September,	64,654,000	67,137,000	73,724,000	74,160,000	84,296,000	88,296,000	91,478,000	103,612,000	102,103,000	107,752,000	106,772,000	114,188,000
October,	63,770,000	62,735,000	67,028,000	71,762,000	79,551,000	81,770,000	89,589,000	98,358,000	103,389,000	106,560,000	103,602,000	108,290,000
November,	61,204,000	62,231,000	64,881,000	71,933,000	72,762,000	78,177,000	86,719,000	93,648,000	101,324,000	105,175,000	103,477,000	108,054,000
December,	66,700,000	65,108,000	70,443,000	79,449,000	76,594,000	86,355,000	85,840,000	97,844,000	113,268,000	125,434,000	114,721,000	125,119,000
Average,	66,105,000	65,382,000	69,499,000	78,360,000	80,793,000	83,651,000	92,111,000	98,059,000	104,645,000	110,345,000	110,277,000	118,114,000
Population,	724,180	744,720	765,430	787,880	810,340	832,790	855,250	877,700	892,740	907,780	922,820	937,860
Per capita,	91.4	87.8	90.8	99.5	99.7	100.4	107.7	111.7	117.2	121.6	119.5	125.9

See note at end of this table.

TABLE No. 27. — (*Pump Basis.*) *Consumption of Water, etc.* — Concluded.
[Gallons per Day.]

MONTH.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.
January, . . .	130,878,000	126,093,000	137,730,000	132,376,000	133,275,000	127,568,000	123,281,000	137,277,000	113,489,000	117,387,000	109,689,000	110,202,000
February, . . .	140,595,000	130,766,000	150,822,000	146,199,000	130,763,000	131,083,000	124,359,000	141,440,000	120,713,000	127,083,000	108,361,000	112,338,000
March, . . .	120,879,000	123,570,000	134,202,000	128,884,000	126,842,000	117,078,000	116,669,000	122,804,000	107,871,000	110,106,000	102,241,000	109,944,000
April, . . .	111,898,000	118,428,000	121,556,000	128,926,000	125,335,000	112,775,000	111,656,000	113,308,000	101,086,000	103,609,000	98,085,000	100,326,000
May, . . .	115,804,000	122,404,000	123,502,000	131,040,000	123,305,000	112,073,000	118,095,000	114,543,000	101,311,000	105,821,000	98,940,000	103,940,000
June, . . .	117,441,000	121,882,000	125,623,000	139,843,000	125,179,000	114,082,000	114,145,000	118,793,000	108,193,000	114,165,000	104,252,000	103,349,000
July, . . .	124,769,000	118,726,000	128,779,000	138,232,000	126,765,000	122,743,000	123,052,000	120,261,000	112,034,000	106,233,000	101,074,000	106,392,000
August, . . .	121,158,000	120,591,000	131,098,000	128,073,000	121,781,000	118,373,000	111,091,000	112,968,000	106,660,000	105,786,000	101,331,000	110,090,000
September, . . .	120,103,000	121,685,000	124,751,000	129,972,000	118,043,000	112,434,000	108,726,000	112,352,000	105,449,000	109,873,000	108,043,000	108,691,000
October, . . .	118,301,000	116,561,000	124,051,000	124,189,000	115,939,000	112,332,000	106,873,000	110,220,000	103,756,000	105,241,000	103,622,000	108,008,000
November, . . .	116,693,000	113,746,000	119,627,000	117,119,000	111,664,000	107,528,000	105,373,000	109,289,000	101,441,000	101,228,000	101,474,000	103,835,000
December, . . .	122,696,000	130,995,000	122,407,000	124,468,000	115,733,000	121,994,000	104,592,000	110,114,000	102,480,000	108,741,000	102,074,000	106,777,000
Average, . . .	121,671,000	122,085,000	128,561,000	130,712,000	122,851,000	117,458,000	113,951,000	118,546,000	107,466,000	109,489,000	103,227,000	106,994,000
Population, . . .	955,920	981,720	1,007,520	1,025,880	1,051,420	1,077,090	1,103,290	1,129,500	1,155,710	1,181,920	1,208,160	1,234,460
Per capita, . . .	127.3	124.4	127.6	127.4	116.8	109.1	103.3	105.0	93.0	92.6	85.4	86.7

This table includes the water consumed in the cities and towns enumerated in Table No. 26, together with the water consumed in Newton, which is included in the Metropolitan Water District but has not been supplied from the Metropolitan Works, and a small section of the town of Saugus.

TABLE No. 28. — *Chemical Examinations of Water from the Wachusett Reservoir, Clinton.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	Total.	Dissolved.	Suspended.		
128530	Jan. 4	V. slight.		.10	None.	V. faintly vegetable.	2.45	0.95	.0026	.0136	.0130	.0006	.22	1.1
128889	Jan. 18	V. slight.		.11	V. faintly vegetable.	Faintly vegetable.	3.00	1.00	.0016	.0014	.0100	.0014	.28	0.8
129004	Feb. 1	V. slight.		.10	V. faintly vegetable.	Distinctly vegetable.	3.05	1.25	.0014	.0106	.0082	.0024	.27	1.1
129270	Feb. 15	V. slight.		.12	V. faintly vegetable.	Faintly vegetable.	3.40	1.05	.0012	.0114	.0094	.0020	.30	1.1
129647	Mar. 7	V. slight.		.15	Faintly vegetable.	Faintly vegetable.	3.10	1.45	.0024	.0112	.0106	.0006	.29	1.0
129832	Mar. 21	V. slight.		.13	Faintly vegetable.	Distinctly vegetable.	3.50	1.50	.0028	.0082	.0076	.0006	.30	1.0
130018	Apr. 4	None.		.19	Faintly vegetable.	Faintly vegetable.	3.10	1.20	.0018	.0104	.0090	.0014	.27	1.1
130232	Apr. 18	None.		.15	V. faintly vegetable.	Faintly vegetable.	3.60	1.20	.0018	.0104	.0086	.0018	.25	1.1
130522	May 2	V. slight.		.10	V. faintly vegetable.	Faintly vegetable.	2.65	1.00	.0012	.0118	.0098	.0020	.27	1.0
130777	May 16	V. slight.		.20	V. faintly vegetable.	Faintly vegetable.	3.00	1.10	.0010	.0116	.0094	.0022	.26	1.0
131071	June 6	V. slight.		.20	V. faintly vegetable.	Faintly vegetable.	2.85	1.05	.0006	.0124	.0092	.0032	.26	1.1
131371	June 20	None.		.19	V. faintly vegetable.	Faintly vegetable.	3.35	1.75	.0014	.0108	.0092	.0016	.26	1.0
131640	July 5	V. slight.		.34	V. faintly vegetable.	Faintly vegetable.	3.85	1.65	.0100	.0192	.0148	.0044	.24	1.0
132004	July 25	V. slight.		.23	V. faintly vegetable.	Faintly vegetable.			.0036	.0114	.0108	.0006	.28	1.1
132485	Aug. 9	V. slight.		.25	Faintly vegetable.	Distinctly vegetable.			.0006	.0133	.0114	.0024	.26	1.0
132898	Aug. 29	V. slight.		.21	V. faintly vegetable.	Faintly vegetable.			.0024	.0134	.0120	.0014	.25	1.1
133107	Sept. 12	None.		.19	V. faintly vegetable.	Faintly vegetable.			.0020	.0130	.0130	.0028	.22	0.8
133393	Sept. 26	V. slight.		.18	V. faintly vegetable.	V. faintly vegetable.			.0024	.0126	.0114	.0012	.26	1.0
133709	Oct. 17	V. slight.		.16	V. faintly vegetable.	Faintly vegetable.			.0022	.0140	.0102	.0038	.24	0.5
134126	Nov. 7	V. slight.		.15	V. faintly vegetable.	Faintly vegetable.	3.50	1.35	.0016	.0100	.0092	.0008	.28	1.1
134376	Nov. 21	V. slight.		.13	V. faintly vegetable.	Faintly vegetable.			.0022	.0102	.0092	.0010	.28	1.0
134636	Dec. 5	V. slight.		.14	V. faintly vegetable.	V. faintly vegetable.			.0042	.0120	.0114	.0006	.28	1.1
134951	Dec. 26	V. slight.		.14	V. faintly vegetable.	V. faintly vegetable.	3.05	1.30	.0024	.0112	.0102	.0010	.28	1.0
Av.	.....	.....	.....	.17	.....	.....	3.12	1.23	.0023	.0120	.0103	.0017	.27	1.0

TABLE No. 29. — *Chemical Examinations of Water from the Sudbury Reservoir.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.	Suspended.		
128605	Jan. 3	V. slight.	Slight.	.21	V. faintly vegetable.	Faintly vegetable.	3.95	1.05	.0026	.0178	.0106	.0072	.34	1.4
129064	Jan. 31	V. slight.	V. slight.	.12	Faintly vegetable.	Distinctly vegetable.	3.70	1.00	.0026	.0156	.0128	.0028	.38	1.3
129495	Feb. 28	None.	V. slight.	.18	Faintly vegetable.	Distinctly vegetable.	3.80	1.50	.0020	.0126	.0110	.0016	.30	1.3
129992	Apr. 3	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	3.55	1.55	.0026	.0124	.0118	.0006	.30	1.4
130550	May 3	V. slight.	V. slight.	.25	V. faintly vegetable.	Faintly vegetable.	3.70	1.15	.0026	.0134	.0106	.0028	.36	1.0
131048	June 5	V. slight.	V. slight.	.25	V. faintly vegetable.	Faintly vegetable.	3.75	1.95	.0010	.0166	.0138	.0028	.37	1.4
131596	July 3	V. slight.	Slight.	.22	Faintly vegetable.	Faintly vegetable.	4.50	1.80	.0048	.0188	.0140	.0048	.38	1.4
132381	Aug. 7	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	-	-	.0010	.0180	.0160	.0020	.36	1.6
133071	Sept. 11	V. slight.	V. slight.	.15	V. faintly vegetable.	Faintly vegetable.	-	-	.0028	.0152	.0126	.0026	.31	1.0
133674	Oct. 13	None.	V. slight.	.19	V. faintly vegetable.	Faintly vegetable.	-	-	.0032	.0144	.0118	.0026	.30	1.4
134332	Nov. 20	V. slight.	V. slight.	.14	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	-	-	.0018	.0122	.0098	.0024	.28	1.1
134761	Dec. 8	V. slight.	V. slight.	.15	V. faintly unpleasant.	Faintly unpleasant.	3.55	1.15	.0042	.0142	.0118	.0024	.31	1.3
Av.	.....	.....	.....	.19	.....	.....	3.81	1.39	.0026	.0151	.0122	.0029	.33	1.3

TABLE No. 30. — *Chemical Examinations of Water from Spot Pond, Stoneham.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			ODOR.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.	Cold.	Hot.	Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.	Suspended.		
128809	Jan. 17	None.	V. slight.	.03	V. faintly vegetable.	Faintly vegetable.	3.75	1.35	.0012	.0142	.0112	.0030	.38	1.4
129158	Feb. 7	V. slight.	V. slight.	.06	Faintly vegetable.	Distinctly vegetable.	3.75	1.15	.0006	.0134	.0108	.0026	.38	1.4
129611	Mar. 6	V. slight.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	4.05	1.75	.0020	.0150	.0136	.0014	.38	1.3
130090	Apr. 10	V. slight.	V. slight.	.08	None.	V. faintly vegetable.	3.80	1.15	.0028	.0142	.0114	.0028	.37	1.3
130617	May 8	V. slight.	V. slight.	.01	V. faintly vegetable.	Faintly vegetable.	4.40	1.25	.0016	.0122	.0102	.0020	.37	1.3
131311	June 19	V. slight.	V. slight.	.10	Faintly vegetable and earthy.	Distinctly vegetable and earthy.	4.60	1.85	.0016	.0148	.0112	.0036	.36	1.3
131718	July 10	V. slight.	V. slight.	.04	Faintly vegetable.	Distinctly vegetable.	3.45	1.00	.0034	.0142	.0118	.0024	.38	1.3
132695	Aug. 21	V. slight.	V. slight.	.05	V. faintly vegetable.	Faintly vegetable.	3.95	1.35	.0020	.0158	.0124	.0034	.38	1.7
133244	Sept. 18	V. slight.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	-	-	.0034	.0172	.0146	.0026	.36	1.4
133691	Oct. 16	V. slight.	V. slight.	.10	V. faintly vegetable and earthy.	Faintly vegetable and earthy.	-	-	.0020	.0148	.0132	.0016	.36	1.6
134494	Nov. 27	None.	V. slight.	.10	V. faintly vegetable.	Faintly vegetable.	4.60	1.55	.0052	.0168	.0128	.0040	.35	1.4
134769	Dec. 11	V. slight.	V. slight.	.07	V. faintly vegetable and earthy.	Faintly vegetable and earthy.	3.50	1.50	.0026	.0152	.0122	.0030	.35	1.6
Av.	.....	.....	.....	.07	.....	.....	3.99	1.39	.0024	.0148	.0121	.0027	.37	1.4

TABLE No. 31. — *Chemical Examinations of Water from Lake Cochituate.*
[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	Color.					Platinum Standard.	Total.	Loss on Ignition.	Freq.			Total.	Dissolved.	Suspended.
					Cold.	Hot.								
128670	Jan. 5	V. slight.	Slight.	.19	V. faintly vegetable.	Faintly cucumber.	5.85	1.80	.0076	.0226	.0174	.0052	.69	2.5
129109	Feb. 1	V. slight.	Slight.	.13	Faintly cucumber synura.	Distinctly cucumber synura.	6.35	2.15	.0022	.0236	.0178	.0058	.75	2.7
129552	Mar. 1	V. slight.	Slight.	.35	Faintly cucumber.	Distinctly cucumber.	7.75	3.05	.0034	.0236	.0196	.0040	.80	2.7
130020	Apr. 4	V. slight.	Slight.	.28	V. faintly vegetable and unpleasant.	Faintly vegetable and unpleasant.	7.00	2.25	.0082	.0216	.0156	.0060	.75	2.7
130496	May 2	V. slight.	Slight.	.30	Faintly vegetable.	Faintly vegetable.	7.25	2.45	.0018	.0230	.0194	.0036	.72	2.5
131056	June 5	V. slight.	Slight.	.26	Faintly vegetable.	Distinctly vegetable.	6.15	2.00	.0018	.0204	.0172	.0032	.72	2.5
131638	July 5	None.	V. slight.	.27	Faintly vegetable.	Distinctly vegetable.	7.00	2.45	.0082	.0222	.0180	.0042	.72	2.6
132419	Aug. 8	V. slight.	V. slight.	.27	Faintly vegetable.	Distinctly vegetable.	-	-	.0022	.0206	.0178	.0028	.70	2.3
133052	Sept. 11	V. slight.	V. slight.	.20	Faintly vegetable.	Distinctly vegetable.	6.45	2.35	.0020	.0302	.0204	.0098	.70	2.3
133711	Oct. 17	V. slight.	V. slight.	.18	V. faintly vegetable and sweetish.	Faintly vegetable and sweetish.	-	-	.0020	.0276	.0190	.0086	.72	2.5
134413	Nov. 22	V. slight.	V. slight.	.21	V. faintly vegetable.	Faintly vegetable.	-	-	.0172	.0218	.0184	.0034	.71	2.5
Av.	.....	.....	.....	.24	.....	.....	6.72	2.31	.0051	.0234	.0182	.0052	.73	2.5

TABLE No. 32. — *Chemical Examinations of Water from a Tap at the State House, Boston.*

[Parts per 100,000.]

Number.	Date of Collection.	APPEARANCE.			Odor.		RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
		Turbidity.	Sediment.	COLOR.			Total.	Loss on Ignition.	Free.	ALBUMINOID.				
										Total.	Dissolved.	Suspended.		
28599	Jan. 3	V. slight.	V. slight.	.12	Faintly vegetable.	Faintly vegetable.	4.05	1.30	.0012	.0140	.0062	.0078	.29	1.3
29156	Feb. 7	V. slight.	V. slight.	.21	Faintly vegetable.	Distinctly vegetable.	4.30	1.35	.0010	.0126	.0088	.0038	.38	1.4
29726	Mar. 14	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	3.25	1.05	.0034	.0120	.0098	.0022	.40	1.6
29986	Apr. 3	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	4.55	1.60	.0018	.0114	.0094	.0020	.38	1.6
30456	May 1	V. slight.	V. slight.	.20	Faintly vegetable.	Faintly vegetable.	5.40	2.55	.0006	.0130	.0104	.0026	.36	1.3
31059	June 6	V. slight.	V. slight.	.20	V. faintly vegetable.	Faintly vegetable.	4.25	2.00	.0004	.0124	.0104	.0020	.38	1.4
31583	July 3	V. slight.	V. slight.	.22	Faintly vegetable.	Distinctly vegetable.	5.90	3.15	.0014	.0150	.0118	.0032	.38	1.4
32349	Aug. 7	V. slight.	V. slight.	.21	V. faintly vegetable.	Faintly vegetable.	—	—	.0010	.0154	.0144	.0010	.39	1.6
32947	Sept. 5	V. slight.	V. slight.	.18	V. faintly vegetable.	Faintly vegetable.	—	—	.0004	.0152	.0130	.0022	.36	1.6
33523	Oct. 2	V. slight.	V. slight.	.13	—	—	—	—	.0008	.0130	.0116	.0014	.36	1.3
34368	Nov. 21	V. slight.	V. slight.	.13	V. faintly vegetable.	Faintly vegetable.	—	—	.0018	.0126	.0116	.0010	.34	1.3
34632	Dec. 4	V. slight.	V. slight.	.12	V. faintly vegetable.	Faintly vegetable.	4.55	1.80	.0020	.0128	.0112	.0016	.30	1.3
Av.	.....	.....	.....	.18	.....	.....	4.53	1.85	.0013	.0133	.0107	.0026	.36	1.4

TABLE No. 33. — *Averages of Examinations of Water from Various Parts of the Metropolitan Water Works in 1916.*
[Parts per 100,000.]

LOCALITY.	Samples collected.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Hardness.
			Total.	Loss on Ignition.	Free.	ALBUMINOID.				
						Total.	Dissolved.	Suspended.		
Quinepoxet River, Holden, ¹	.	.52	3.66	1.43	.0017	.0165	.0142	.0023	.30	0.9
Stillwater River, Sterling, ¹	.	.37	3.45	1.35	.0017	.0136	.0117	.0019	.23	0.9
Wachusett Reservoir, West Boylston, ¹	.	.34	3.55	1.39	.0019	.0136	.0114	.0022	.26	1.0
Wachusett Reservoir, Clinton, surface, ²	.	.17	3.12	1.23	.0023	.0120	.0103	.0017	.27	1.0
Wachusett Reservoir, Clinton, bottom, ²	.	.16	3.13	1.15	.0016	.0111	.0095	.0016	.27	1.0
Marlborough (Walker's Brook),	.	.54	18.67	5.73	.0848	.0856	.0262	.0094	2.70	6.2
Marlborough Brook filter beds, effluent, ³	.	.09	14.13		.0022	.0104			2.05	5.1
Wachusett Aqueduct, Southborough,	.	.22	3.45	1.28	.0017	.0129	.0110	.0019	.28	1.2
Sudbury Reservoir, surface,	.	.19	3.81	1.39	.0026	.0151	.0122	.0029	.33	1.3
Sudbury Reservoir, bottom,	.	.19	3.95	1.29	.0029	.0139	.0113	.0026	.33	1.3
Framingham Reservoir No. 3, inlet,	.	.16	4.09	1.38	.0025	.0136	.0113	.0023	.35	1.4
Framingham Reservoir No. 3, near dam,	.	.20	3.71	1.47	.0052	.0166	.0130	.0035	.34	1.3
Hopkinton Reservoir, inlet,	.	1.41	6.17	3.34	.0040	.0327	.0299	.0028	.45	1.4
Hopkinton Reservoir, surface,	.	.75	4.44	1.96	.0022	.0210	.0185	.0025	.40	1.3
Hopkinton Reservoir, bottom,	.	.71	4.61	2.04	.0034	.0212	.0179	.0033	.41	1.2
Ashland Reservoir, inlet,	.	1.28	5.99	3.15	.0029	.0304	.0273	.0031	.41	1.4
Ashland Reservoir, surface,	.	.80	4.99	2.18	.0027	.0232	.0210	.0022	.37	1.3
Ashland Reservoir, bottom,	.	.68	4.48	1.99	.0027	.0213	.0188	.0025	.36	1.2
Framingham Reservoir No. 2, inlet,	.	.77	5.18	2.25	.0046	.0247	.0216	.0031	.47	1.4
Framingham Reservoir No. 2, near dam,	.	.84	4.87	2.35	.0059	.0260	.0232	.0028	.42	1.3
Lake Cochituate, surface, ⁴	.	.24	6.72	2.31	.0051	.0234	.0182	.0052	.73	2.5
Lake Cochituate, bottom,	.	.51	7.58	2.69	.0453	.0251	.0193	.0058	.75	2.8
Weston Reservoir,	.	.16	3.80	1.53	.0033	.0251	.0125	.0016	.31	1.3
Terminal chamber, Sudbury Aqueduct,	.	.18	3.82	1.68	.0026	.0138	.0114	.0024	.35	1.3
Spot Pond,	.	.07	3.99	1.39	.0024	.0148	.0121	.0027	.37	1.4
Tap in Revere,	.	.09	4.07	1.51	.0016	.0135	.0116	.0019	.36	1.4
Tap at State House,	.	.18	4.53	1.85	.0013	.0133	.0107	.0026	.36	1.4
Tap in Quincy,	.	.16	4.11	1.52	.0008	.0111	.0098	.0013	.36	1.5

¹ Averages of 22 samples.

² Averages of 23 samples.

³ Averages of 9 samples.

⁴ Averages of 11 samples.

TABLE No. 34. — *Chemical Examinations of Water from a Faucet in Boston, from 1892 to 1916.*

[Parts per 100,000.]

YEAR.	COLOR.	RESIDUE ON EVAPORATION.		AMMONIA.				Chlorine.	Oxygen consumed.	Hardness.
	Platinum Standard.	Total.	Loss on Ignition.	Free.	ALBUMINOID.					
					Total.	Dissolved.	Suspended.			
1892, . . . .	.37	4.70	1.67	.0007	.0168	.0138	.0030	.41	-	1.9
1893, . . . .	.53	4.54	1.84	.0010	.0174	.0147	.0027	.38	.60	1.8
1894, . . . .	.58	4.64	1.83	.0006	.0169	.0150	.0019	.41	.63	1.7
1895, . . . .	.59	4.90	2.02	.0006	.0197	.0175	.0022	.40	.69	0.7
1896, . . . .	.45	4.29	1.67	.0005	.0165	.0142	.0023	.37	.56	1.4
1897, . . . .	.55	4.82	1.84	.0009	.0193	.0177	.0016	.40	.64	1.6
1898, . . . .	.40	4.19	1.60	.0008	.0152	.0136	.0016	.29	.44	1.4
1899, . . . .	.28	3.70	1.30	.0006	.0136	.0122	.0014	.24	.35	1.1
1900, . . . .	.29	3.80	1.20	.0012	.0157	.0139	.0018	.25	.38	1.3
1901, . . . .	.29	4.43	1.64	.0013	.0158	.0142	.0016	.30	.42	1.7
1902, . . . .	.30	3.93	1.56	.0016	.0139	.0119	.0020	.29	.40	1.3
1903, . . . .	.29	3.98	1.50	.0013	.0125	.0110	.0015	.30	.39	1.5
1904, . . . .	.23	3.93	1.59	.0023	.0139	.0121	.0018	.34	.37	1.5
1905, . . . .	.24	3.86	1.59	.0020	.0145	.0124	.0021	.35	.35	1.4
1906, . . . .	.24	3.86	1.39	.0018	.0159	.0134	.0025	.34	.36	1.3
1907, . . . .	.22	3.83	1.40	.0013	.0129	.0109	.0020	.33	.32	1.3
1908, . . . .	.19	3.50	1.35	.0011	.0115	.0092	.0024	.33	.26	1.2
1909, . . . .	.18	3.46	1.43	.0011	.0128	.0103	.0025	.28	.25	1.3
1910, . . . .	.14	3.05	1.24	.0013	.0118	.0102	.0016	.28	.22	1.1
1911, . . . .	.25	4.18	1.66	.0015	.0156	.0128	.0029	.38	.33	1.4
1912, . . . .	.17	3.86	1.23	.0018	.0154	.0119	.0034	.36	.29	1.7
1913, . . . .	.13	3.96	1.15	.0014	.0150	.0120	.0026	.35	.26	1.5
1914, . . . .	.14	4.12	1.19	.0014	.0138	.0116	.0022	.39	.25	1.4
1915, . . . .	.16	37.3	1.04	.0015	.0157	.0134	.0023	.38	.25	1.4
1916, . . . .	.18	4.53	1.85	.0013	.0133	.0107	.0026	.36	-	1.4

TABLE No. 35. — *Microscopic Organisms in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1916 inclusive.*

YEAR.	WACHUSETT RESERVOIR.		SUDBURY RESERVOIR.		LAKE COCHITUATE.		FRAMINGHAM RESERVOIR No. 3.		FRAMINGHAM RESERVOIR No. 2.		ASHLAND RESERVOIR		HOPKINTON RESERVOIR.		WHITEHALL RESERVOIR.	
	Surface.	Bottom.	Surface.	Bottom.	Surface.	Bottom.	Surface.	Mid-depth.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.	Surface.
1898,	-	-	354	149	830	696	390	245	263	944	690					
1899,	-	-	470	252	905	644	440	218	357	715	393					
1900,	-	-	498	361	1,758	1,071	645	365	390	980	437					
1901,	-	-	337	225	992	702	336	149	244	450	705					
1902,	-	-	590	402	1,071	730	627	204	550	588	198					
1903,	-	-	549	388	931	795	459	169	323	231	327					
1904,	313	-	517	376	663	542	475	174	153	106	375					
1905,	769	592	644	502	1,255	503	535	158	289	240	147					
1906,	446	272	953	714	1,407	1,143	692	226	431	475	1,279					
1907,	425	212	513	419	1,123	1,200	413	205	378	336	961					
1908,	731	466	850	885	1,559	1,241	932	725	699	516	708					
1909,	2,151	1,937	2,474	2,513	1,142	1,198	2,372	610	603	294	445					
1910,	480	328	464	556	928	1,033	455	436	426	387	154					
1911,	649	368	990	988	1,942	2,216	1,140	378	592	457	397					
1912,	555	368	939	882	4,682	7,873	888	241	665	516	390					
1913,	449	270	553	541	4,964	7,322	560	253	414	298	494					
1914,	753	309	735	692	2,036	4,189	532	-	327	325	89					
1915,	519	356	1,005	828	1,900	3,213	701	-	450	284	625					
1916,	922	550	930	992	2,708	1,949	837	-	425	347	148					

See note at end of this table.

TABLE No. 35. — *Microscopic Organisms in Water, etc.* — Concluded.

[Standard units per cubic centimeter; averages from weekly or biweekly observations.]

YEAR.	WESTON RESERVOIR.		SPOT POND.		CHESTNUT HILL RESERVOIR.				TAPS.					
	Surface.		Surface.		SUBBURY AQUEDUCT.		COCHITUATE AQUEDUCT.		EFFLUENT GATE-HOUSE.		Southern Low Service.	Southern High Service.	Northern Low Service.	Northern High Service.
					Inlet.		Inlet.		No. 2.					
1898,	-	485	304	544	304				230	-	-	-	-	
1899,	-	1,129	359	992					192	201	-	-	-	
1900,	-	573	568	1,139	897				468	452	-	-	-	
1901,	-	628	344	697	413				243	280	-	-	-	
1902,	-	581	563	937	525				367	451	-	-	-	
1903,	-	650	450	860	435				286	398	-	-	-	
1904,	-	465	405	838	472				303	470	274	189		
1905,	-	609	551	904	554				528	671	363	388		
1906,	783	671	631	1,042	721				550	583	326	422		
1907,	443	590	349	909	419				312	427	205	422		
1908,	979	741	783	1,073	689				666	695	443	481		
1909,	2,399	1,079	1,999	632	1,899				1,913	1,959	1,313	677		
1910,	625	622	457	-	465				447	421	221	374		
1911,	934	748	700	1,382	954				778	735	349	461		
1912,	1,117	716	855	3,887	919				1,035	967	412	462		
1913,	565	607	535	2,622	850				531	410	237	356		
1914,	757	648	492	-	540				603	549	249	412		
1915,	725	656	643	-	601				597	631	262	419		
1916,	857	811	842	-	1,041				872	858	409	520		

NOTE. — A large growth of *Asterionella* originated in the Wachusett Reservoir in 1909, causing the large number of organisms in the water of Sudbury Reservoir and Framingham Reservoir No. 3, Weston and Chestnut Hill reservoirs, Spot Pond and in the water drawn from taps.

TABLE NO. 36. — *Number of Bacteria per Cubic Centimeter in Water from Various Parts of the Metropolitan Water Works, from 1898 to 1916 inclusive.*

[Averages of weekly determinations.]

YEAR.	CHESTNUT HILL RESERVOIR.			SOUTHERN SERVICE TAPS.	
	Sudbury Aqueduct Terminal Chamber.	Cochituate Aqueduct.	Effluent Gate-house No. 2.	Low Service, 180 Boylston Street.	High Service, 1 Ashburton Place.
1898,	207	145	111	96	—
1899,	224	104	217	117	123
1900,	248	113	256	188	181
1901,	225	149	169	162	168
1902,	203	168	121	164	246
1903,	76	120	96	126	243
1904,	347	172	220	176	355
1905,	495	396	489	231	442
1906,	231	145	246	154	261
1907,	147	246	118	130	176
1908,	162	138	137	136	148
1909,	198	229	119	150	195
1910,	216	—	180	178	213
1911,	205	204	151	175	197
1912,	429	450	227	249	259
1913,	123	243	157	119	140
1914,	288	—	252	174	220
1915,	163	—	128	117	134
1916,	128	—	85	102	105
Averages,	227	201	183	155	211

TABLE No. 37. — *Colors of Water from Various Parts of the Metropolitan Water Works in 1916. (Averages of Weekly Determinations.)*
[Platinum Standard.]

MONTH.	WACHUSETT RESERVOIR.				SUDBURY RESERVOIR.				FRAM-INGHAM RESERVOIR No. 3.	LAKE COCHITUATE.				CHESTNUT HILL RESERVOIR.			SPOT POND.	FELS RESERVOIR.	NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	End of Open Channel.		Surface.	Mid-depth.	Bottom.	Influent Streams. ¹	Inlet (Sudbury Aqueduct).	Inlet (Cochituate Aqueduct).	Effluent Gate-house No. 2.			Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Everett (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).
January,	11	11	11	16	21	19	19	16	19	17	19	21	29	19	—	17	8	7	17	7	17	17
February,	10	11	11	17	15	16	17	16	16	20	18	18	36	17	—	16	8	7	16	7	16	16
March,	10	9	10	16	15	15	16	14	16	31	19	27	48	16	—	15	6	6	15	9	15	15
April,	11	11	11	20	15	15	15	20	16	24	23	24	38	16	—	14	8	4	14	5	14	14
May,	12	12	11	18	16	15	15	18	17	22	22	24	45	16	—	12	4	4	11	4	12	13
June,	12	12	12	18	17	18	18	21	18	22	21	46	51	17	—	13	4	4	11	4	15	13
July,	13	12	13	17	15	16	17	19	15	23	18	65	—	16	—	12	4	4	13	5	15	14
August,	13	14	13	16	14	16	24	14	15	19	21	157	48	14	—	12	5	4	13	5	13	13
September,	13	14	12	13	12	13	12	13	13	17	18	94	36	12	—	10	6	5	12	6	12	11
October,	12	12	12	12	11	11	12	12	11	13	18	132	31	11	—	9	5	6	10	7	10	9
November,	11	11	11	11	11	11	13	11	11	13	18	78	30	10	—	10	5	5	11	6	9	9
December,	11	11	11	17	11	10	11	17	11	14	14	15	30	11	—	10	6	5	10	6	10	10
Averages,	12	12	12	16	14	15	16	16	15	20	19	58	35	15	—	12	6	5	13	6	13	13

¹ The colors given in this column represent the combined colors of the waters of the four principal feeders. The color of each is determined monthly, and due weight is given in combining the results to the sizes of the streams.

TABLE No. 38. — *Temperatures of Water from Various Parts of the Metropolitan Water Works in 1916. (Averages of Weekly Determinations.)*

[The temperatures are taken at the same places and times as the samples for microscopical examination; the depth given for each reservoir is the depth from high-water mark.]

[Degrees Fahrenheit.]

MONTH.	WACHUSETT ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 107 FEET).			SUDBURY ¹ RESERVOIR (DEPTH AT PLACE OF OBSERVATION 54.5 FEET).			WACHU- SETT AQUE- DUCT.			FRAMINGHAM ¹ RESERVOIR No. 3 (DEPTH AT PLACE OF OBSERVATION 20.5 FEET).			LAKE COCHITUATE ¹ (DEPTH AT PLACE OF OBSERVATION 62.0 FEET).			CHEST- NUT HILL RESER- VOIR.			Spot Pond ¹ (DEPTH AT PLACE OF OBSERVATION 28.0 FEET).			NORTHERN SERVICE.		SOUTHERN SERVICE.	
	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	End of Open Channel.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Surface.	Mid-depth.	Bottom.	Effluent Gate-house No. 2.	Surface.	Mid-depth.	Bottom.	Tap at Glenwood Yard, Medford (Low Service).	Tap at Fire Station, Hancock Street, Ev- erett (High Service).	Tap at 180 Boylston Street, Boston (Low Service).	Tap at 1 Ashburton Place, Boston (High Service).	
January, .	34.4	34.3	35.0	34.5	36.0	36.2	35.3	36.9	37.0	36.9	36.0	37.5	36.0	37.2	35.5	36.0	37.2	35.5	34.5	36.0	38.8	36.6	39.7	40.4	
February, .	32.8	33.0	—	32.9	33.8	34.0	34.3	34.5	34.8	34.3	33.8	34.0	35.0	36.1	37.0	37.8	36.1	37.0	38.0	37.8	38.5	38.0	38.0	38.7	
March, .	33.8	34.0	34.2	33.3	34.5	34.3	35.0	34.2	33.9	34.5	34.4	36.0	35.8	36.6	37.1	38.5	36.6	37.1	38.5	38.5	41.5	41.8	43.2	44.3	
April, .	37.6	36.0	37.9	39.6	39.0	40.3	40.3	42.8	41.3	43.9	40.9	41.5	40.8	42.4	41.0	40.3	42.4	41.0	40.3	42.0	41.5	41.8	43.2	44.3	
May, .	50.9	48.0	46.3	55.3	54.2	52.5	50.0	57.0	57.2	56.3	55.3	45.3	43.8	56.7	54.8	54.6	53.5	53.2	54.6	53.5	52.8	54.2	55.3	57.1	
June, .	62.6	53.1	49.8	64.8	63.8	59.5	58.0	66.1	67.2	64.9	63.8	48.3	46.8	65.9	63.2	62.5	61.0	63.2	62.5	61.0	60.0	62.3	62.6	64.0	
July, .	71.0	59.5	49.3	73.3	66.8	65.0	69.0	74.8	75.8	72.7	73.8	50.0	45.8	73.4	73.2	73.0	70.3	73.2	73.0	66.0	67.8	70.3	69.2	72.1	
August, .	72.5	58.3	49.9	74.4	69.0	67.8	64.0	75.1	77.4	73.8	72.8	50.0	46.7	74.0	73.2	73.0	71.6	73.2	73.0	68.0	69.4	71.6	71.6	73.8	
September, .	67.1	67.5	51.1	67.5	67.5	66.0	61.8	67.4	68.4	66.5	64.5	50.0	46.0	68.9	68.0	67.4	68.9	68.0	67.4	66.0	68.3	69.5	68.6	69.8	
October, .	58.5	55.7	51.3	59.4	58.3	60.0	54.3	57.1	56.9	57.5	56.6	50.5	46.3	59.8	58.8	58.2	59.5	58.8	58.2	59.5	62.4	60.6	61.0	61.9	
November, .	48.1	46.3	49.5	45.6	45.5	48.0	43.0	42.9	41.3	44.6	43.8	43.0	42.8	46.8	45.9	44.5	47.9	46.8	45.9	47.9	51.3	47.0	48.1	49.8	
December, .	38.5	41.0	39.8	36.8	34.0	38.0	34.0	36.5	35.8	37.0	38.7	37.8	—	37.8	36.9	36.6	37.3	36.9	36.6	37.3	42.8	39.3	39.8	41.9	
Averages, .	50.7	47.2	44.9	51.5	50.2	50.1	48.3	52.1	52.3	51.9	51.4	43.7	42.3	53.0	52.1	51.7	51.1	52.6	52.5	52.9	52.6	52.5	52.9	54.4	

¹ Surface temperatures are averages of weekly determinations. Mid-depth and bottom temperatures are averages of biweekly determinations.

TABLE NO. 39. — *Temperatures of the Air at Three Stations on the Metropolitan Water Works in 1916.*

[Degrees Fahrenheit.]

MONTH.	CHESTNUT HILL RESERVOIR.			FRAMINGHAM.			CLINTON.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
January,	64	2	31.6	63	0	29.8	62	1	29.2
February,	55	—8	24.4	55	—19	22.5	44	—19	20.5
March,	58	2	27.8	59	0	26.7	62	—5	26.7
April,	71	29	45.6	68	29	45.8	67	27	43.7
May,	81	36	58.3	82	37	58.7	76	39	56.8
June,	84	44	62.0	84	39	62.3	80	45	60.6
July,	92	51	72.6	91	50	73.0	87	51	71.1
August,	95	45	71.0	95	46	70.8	88	49	69.2
September,	91	39	64.2	87	38	63.7	84	40	61.5
October,	83	31	55.0	82	26	53.3	79	29	51.8
November,	68	14	41.7	65	12	39.8	62	17	39.7
December,	58	7	31.5	58	6	29.4	55	5	28.8
Averages,	—	—	48.8	—	—	48.0	—	—	46.6

TABLE No. 40. — Table showing Length of Main Lines of Water Pipes and Connections owned and operated by Metropolitan Water and Sewerage Board, and Number of Valves set in Same, Dec. 31, 1916.

	DIAMETER OF PIPES IN INCHES.															Total.
	60	48	42	40	36	30	24	20	16	14	12	10	8	6	4	
Total length owned and operated Dec. 31, 1915 (feet).	43,676	211,099	9,810	6,989	61,752	49,687	85,349	76,069	67,777	26	26,499	3,786	1,878	985	33	645,415
Gate valves in same,	5	54	1	2	53	41	59	54	81	1	105	18	18	23	1	516
Air valves in same,	51	124	5	3	44	20	42	45	33	—	10	1	—	—	—	378
Length laid or relaid during 1916 (feet), .	126	36	—	—	35	76	—	34	33	—	8	—	—	—	—	348
Gate valves in same,	—	—	—	—	2	1	—	1	—	—	1	—	—	—	—	5
Air valves in same,	2	5	—	—	—	1	—	—	1	—	—	—	—	—	—	9
Length abandoned during 1916 (feet), .	—	43	—	—	—	76	—	34	12	—	—	—	—	—	—	165
Gate valves in same,	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Air valves in same,	2	4	—	—	—	—	—	—	—	—	—	—	—	—	—	6
Length owned and operated Dec. 31, 1916 (feet).	43,802 ¹	211,092	9,810	6,989	61,787	49,687 ²	85,349	76,069	67,798	26	26,507	3,786	1,878	985	33	645,598 ³
Gate valves in same,	5	54	1	2	55	42	59	55	81	1	106	18	18	23	1	521
Air valves in same,	51	125	5	3	44	21	42	45	34	—	10	1	—	—	—	381

¹ Includes 2,035 feet of 76-inch concrete-lined pressure tunnel; 363 feet of 76-inch mortar-lined and concrete-covered steel pipe; 21 feet of 76-inch cast-iron pipe and 85 feet of 60-inch concrete-covered steel pipe.

² Includes 15,565 feet of 30-inch mortar-lined and covered wrought-iron pipe.

³ 122.27 miles.

TABLE No. 41. — *Statement of Cast-iron Hydrant, Blow-off and Drain Pipes, owned and operated by Metropolitan Water and Sewerage Board, Dec. 31, 1916.*

	DIAMETER OF PIPES IN INCHES.								Total.
	24	20	16	12	10	8	6	4	
Total length in use Dec. 31, 1915 (feet),	352	292	3,121	6,685	176	501	3,472	1,472	16,071
Valves in same,	—	—	30	106	2	8	80	43	269
Length laid or relaid in 1916 (feet),	—	—	—	26	—	—	37	—	63
Valves in same,	—	—	—	2	—	—	1	—	3
Length abandoned in 1916 (feet),	—	—	—	14	—	—	—	—	14
Valves in same,	—	—	—	1	—	—	—	—	1
Total length in use Dec. 31, 1916 (feet),	352	292	3,121	6,697	176	501	3,509	1,472	16,120 ¹
Valves in same,	—	—	30	107	2	8	81	43	271

¹ 3.05 miles.

TABLE No. 42. — *Length of Water Pipes, Four Inches in Diameter and Larger, in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1916.*

By whom owned.	INCHES.														TOTALS.						
	60	48	42	40	36	30	28	24	20	18	16	14	13	12	10	8	7	6	4	Feet.	Miles.
Metropolitan Water Works.	43,802	211,092	9,810	6,989	61,787	49,687	-	85,349	76,069	-	67,798	26	-	26,507	3,786	1,878	-	985	33	645,598	122.27
Boston, . . .	-	10,637	15,476	16,105	37,128	93,038	244	78,053	87,831	-	251,476	5,021	-	1,426,215	358,094	803,034	-	1,261,218	106,882	4,550,452	861.83
Somerville, . . .	-	-	-	-	-	-	-	3,721	367	-	4,021	7,950	-	89,332	56,781	106,944	-	214,481	22,088	505,085	95.77
Malden, . . .	-	-	-	-	-	-	-	-	-	-	5,547	9,155	-	80,745	31,276	80,714	-	220,289	55,260	482,986	91.47
Chelsea, . . .	-	-	-	-	-	-	-	-	-	-	5,176	-	-	5,479	39,826	30,268	-	142,784	6,656	230,189	43.60
Everett, . . .	-	-	-	-	-	-	-	2,484	2,900	-	5,204	5,998	-	6,084	42,804	25,258	-	145,559	30,600	266,891	50.55
Quincy, . . .	-	-	-	-	-	-	-	-	-	-	23,232	-	-	29,125	42,024	138,453	994	363,041	97,820	698,268	132.25
Medford, . . .	-	-	-	-	-	-	-	-	-	673	6,775	9,598	-	31,968	39,259	94,003	-	157,620	26,693	366,589	69.43
Melrose, . . .	-	-	-	-	-	-	-	-	-	-	5,223	2,920	-	22,801	19,846	25,720	-	149,239	56,752	282,501	53.50
Revere, ¹ . . .	-	-	-	-	-	-	-	-	-	-	23,800	5,785	1,200	24,125	27,157	32,275	-	98,667	72,283	285,292	54.03
Watertown, . . .	-	-	-	-	-	-	-	-	-	-	400	11,877	-	5,959	12,459	27,043	-	140,206	11,816	209,760	39.73
Arlington, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	24,136	28,212	39,732	-	136,894	15,611	244,585	46.32
Milton, . . .	-	-	-	-	-	-	-	-	-	-	103	44	-	22,556	20,926	52,819	-	152,602	17,027	266,077	50.39
Winthrop, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	4,049	24,073	33,987	-	53,429	57,147	172,685	32.71
Stonham, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	7,425	1,825	5,110	-	105,965	18,281	138,606	26.25
Belmont, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	5,714	16,954	26,315	-	112,075	269	161,327	30.55
Lexington, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	9,000	4,879	35,433	-	119,816	27,794	196,922	37.30
Nahant, . . .	-	-	-	-	-	-	-	-	-	-	-	-	-	150	11,550	4,800	-	36,800	59,208	116,508	22.07
Swampscott, . . .	-	-	-	-	-	-	-	-	-	-	-	4,000	-	6,714	18,306	6,593	-	76,753	9,025	120,436	22.81
Total feet, . . .	43,802	221,729	25,286	23,094	98,915	142,725	244	165,886	173,873	367	398,755	65,419	1,200	1,828,084	800,937	1,570,379	994	3,688,423	691,245	9,941,357	-
Total miles, . . .	8.30	41.99	4.79	4.37	18.73	27.03	0.05	31.42	32.93	0.07	75.52	12.39	0.23	346.23	151.69	297.42	0.19	698.56	130.92	-	1,882.83

¹ Includes small portion of Saugus.

TABLE NO. 43. — *Number of Service Pipes, Meters and Fire Hydrants in the Several Cities and Towns supplied by the Metropolitan Water Works, Dec. 31, 1916, and the Number of Services and Meters installed during the Year 1916.*

CITY OR TOWN.	Services.	Meters.	Fire Hydrants.	Services Installed.	Meters Installed.
Boston,	104,615	61,046	9,517	1,675	7,089
Somerville,	13,418	9,850	1,224	200	702
Malden,	8,097	7,782	587	87	87
Chelsea,	5,125	5,113	397	156	158
Everett,	5,980	3,269	585	89	322
Quincy,	9,705	8,872	1,119	403	630
Medford,	6,409	6,234	692	376	393
Melrose,	4,098	4,296	368	97	106
Revere, ¹	4,589	3,349	297	146	212
Watertown,	2,964	2,967	398	166	345
Arlington,	2,947	2,947	484	211	209
Milton,	1,965	2,024	433	104	104
Winthrop,	2,970	2,899	296	70	70
Stoneham,	1,634	1,611	156	21	22
Belmont,	1,632	1,632	245	202	202
Lexington,	1,206	1,139	220	53	78
Nahant,	745	516	101	16	48
Swampscott,	1,873	1,873	188	68	68
Totals,	179,972	127,419	17,307	4,140	10,845

¹ Includes small portion of Saugus.

TABLE No. 44. — Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base for Each Month at Stations on Metropolitan Water Works during 1916.

1916. MONTH.	Low Service.										SOUTHERN HIGH SERVICE.								
	BOSTON ENGINE HOUSE, BULFINCH STREET.		ALISTON ENGINE HOUSE, HARVARD STREET.		MEDFORD, MYSTIC RESERVOIR.		MEDFORD 1 CITY HALL, HIGH STREET.		SOMERVILLE PUBLIC LIBRARY, HIGHLAND AVENUE.		MALDEN WATER WORKS SHOP, GREEN STREET.		CHELSEA COURT HOUSE.		BOSTON METROPOLITAN WATER WORKS OFFICE, MAIN STREET.		WATERTOWN WATER WORKS OFFICE, MAIN STREET.		
	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.
January, .	163	146	175	167	165	162	166	162	170	164	167	163	165	155	248	232	263	251	
February, .	153	138	174	167	165	162	166	162	169	164	166	162	166	157	248	232	262	251	
March, .	144	135	174	167	165	162	165	161	169	163	166	163	166	159	248	232	262	251	
April, .	150	139	174	166	166	161	165	162	167	162	166	163	166	159	249	233	263	250	
May, .	164	145	175	167	166	161	165	161	168	162	166	161	165	155	249	232	263	249	
June, .	164	144	174	166	166	161	165	161	170	164	165	161	163	153	249	233	263	247	
July, .	163	143	175	168	167	162	166	161	169	164	165	161	163	153	250	238	262	246	
August, .	163	142	175	169	167	162	-	-	170	164	165	160	162	151	248	237	262	244	
September, .	164	142	174	169	167	162	-	-	168	163	164	162	163	153	248	236	262	244	
October, .	164	143	174	169	166	162	-	-	168	164	165	162	163	153	248	235	262	244	
November, .	164	143	174	169	166	163	-	-	168	164	166	162	164	154	248	236	262	247	
December, .	163	144	173	167	166	162	-	-	167	163	166	163	165	154	248	236	263	247	
Averages, .	160	142	174	168	166	162	165	161	169	163	166	162	164	155	248	234	262	248	

¹ Gage removed August 9, City Hall torn down.

TABLE No. 44. — Average Elevation of the Hydraulic Grade Line, in Feet, above Boston City Base, etc. — Concluded.

1916. MONTH.	SOUTHERN HIGH SERVICE — Concluded.								NORTHERN HIGH SERVICE.								NORTHERN EXTRA HIGH SERVICE.			
	BELMONT WATER WORKS SHOP, WAVER- LEY STREET.		MILTON WATER WORKS OFFICE, ADAMS STREET.		FORBES HILL TOWER, QUINCY.		QUINCY WATER WORKS SHOP.		SOMERVILLE PUMPING STA- TION, CEDAR STREET.		MALDEN CITY HALL.		REVERE WATER WORKS OFFICE, BROADWAY.		LYNN ENGINE HOUSE, UNION SQUARE.		WINTHROP TOWN HALL, HERMAN STREET.		Minimum.	Maximum.
	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.	Minimum.	Maximum.		
January, .	261	250	250	241	245	235	244	229	268	249	270	265	267	258	-	-	193	180	428	415
February, .	261	249	249	239	245	234	244	229	269	249	270	266	267	259	-	-	191	175	429	415
March, .	260	248	250	240	244	234	243	230	269	249	270	266	266	256	-	-	191	174	429	417
April, .	262	248	249	239	245	236	244	230	271	249	271	266	267	255	-	-	192	179	427	416
May, .	261	246	249	239	244	234	243	228	268	247	271	265	267	254	-	-	192	179	426	414
June, .	261	246	247	239	244	235	243	228	266	244	270	263	265	253	-	-	191	176	417	405
July, .	261	245	247	237	244	235	243	228	266	246	268	262	262	249	-	-	190	176	423	412
August, .	261	239	246	237	243	233	242	226	267	246	267	262	262	247	-	-	188	173	419	404
September, .	262	241	247	237	244	233	243	226	267	246	270	262	264	251	-	-	192	178	420	409
October, .	261	242	248	238	244	234	244	228	268	245	270	265	267	252	-	-	193	181	428	417
November, .	261	247	249	238	244	234	244	229	267	245	271	265	268	256	265	253	194	182	427	416
December, .	260	245	251	239	244	234	242	230	270	250	270	263	268	257	264	252	194	182	429	419
Averages, .	261	246	248	239	244	234	243	228	268	247	270	264	266	254	265	253	192	178	425	413

* Gage replaced after repairs to Engine House.

APPENDIX NO. 3.

WATER WORKS STATISTICS FOR THE YEAR 1916.

The Metropolitan Water Works supply the Metropolitan Water District which includes the following cities and towns:—

CITY OR TOWN.	Population, Census of 1915.	Estimated Population, July 1, 1916.
Boston,	745,439	762,700
Somerville,	86,854	89,190
Malden,	48,907	50,160
Chelsea,	43,426	45,020
Newton, ¹	43,113	43,960
Everett,	37,718	38,870
Quincy,	40,674	42,030
Medford,	30,509	32,080
Melrose,	16,880	17,260
Revere,	25,178	26,790
Watertown,	16,515	17,280
Arlington,	14,889	15,670
Milton,	8,600	8,850
Winthrop,	12,758	13,470
Stoneham,	7,489	7,590
Swampscott,	7,345	7,580
Lexington,	5,538	5,680
Belmont,	8,081	8,560
Nahant,	1,387	1,440
Total population of Metropolitan Water District,	1,201,300	1,234,180
Saugus, ²	280	280

¹ No water supplied during the year from Metropolitan Water Works.

² Only a small portion of Saugus was supplied with water.

*Pumping.**Chestnut Hill Pumping Station No. 1:—*

Builders of pumping machinery, Holly Manufacturing Company, Quintard Iron Works and E. P. Allis Company.

Description of coal used:— Bituminous: Alpha Special and Davenport. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$4.16 to \$4.49, buckwheat \$3.36. Average price per gross ton \$4.09. Per cent. ashes 10.2.

Chestnut Hill Pumping Station No. 2:—

Builders of pumping machinery, Holly Manufacturing Company.

Description of coal used:— Bituminous: Alpha Special and Davenport. Anthracite: buckwheat. Price per gross ton in bins: bituminous \$4.05 to \$4.35, buckwheat \$2.85 to \$3.02. Average price per gross ton \$3.89. Per cent. ashes 13.2.

Spot Pond Station:—

Builders of pumping machinery, Geo. F. Blake Manufacturing Company and Holly Manufacturing Company.

Description of coal used:— Bituminous: New River, Brazil Smokeless and Davenport. Anthracite: screenings. Price per gross ton in bins: bituminous \$5.08 to \$6.52, screenings \$3.00. Average price per gross ton \$4.55. Per cent. ashes 13.2.

	CHESTNUT HILL PUMPING STATIONS.			
	No. 1.			No. 2.
	Engines Nos. 1 and 2.	Engine No. 3.	Engine No. 4.	Engine No. 12.
Daily pumping capacity (gallons),	16,000,000	20,000,000	30,000,000	40,000,000
Coal consumed for year (pounds),	401,085	4,805	852,810	7,417,190
Cost of pumping, figured on pumping station expenses,	\$2,997.44	\$63.36	\$9,074.49	\$26,463.00
Total pumpage for year, corrected for slip (million gallons),	156.09	5.48	1,334.27	11,084.07
Average dynamic head (feet),	134.54	116.40	119.56	124.54
Gallons pumped per pound of coal,	389.17	1,140.48	1,564.56	1,494.38
Duty on basis of plunger displacement,	44,970,000	115,660,000	158,950,000	158,180,000
Cost per million gallons raised to reservoir,	\$19.2033	\$11.5620	\$6.8011	\$2.3875
Cost per million foot gallons, . . . . .	.1427	.0993	.0569	.0192

	CHESTNUT HILL PUMPING STATION No. 2.	SPOT POND STATION.
	Engines Nos. 5, 6 and 7.	Engines Nos. 8 and 9.
Daily pumping capacity (gallons),	105,000,000	30,000,000
Coal consumed for year (pounds),	3,217,295	2,391,339
Cost of pumping, figured on pumping station expenses,	\$26,183.46	\$15,159.98
Total pumpage for year, corrected for slip (million gallons),	6,326.95	2,600.82
Average dynamic head (feet),	35.27	129.06
Gallons pumped per pound of coal,	1,966.54	1,087.60
Duty on basis of plunger displacement,	61,600,000	119,300,000
Cost per million gallons raised to reservoir,	\$4.1384	\$5.8289
Cost per million foot gallons, . . . . .	.1173	.0452

Consumption.

Estimated total population of the eighteen cities and towns supplied wholly or partially during the year 1916,	1,190,220
Total consumption (gallons), pump basis,	38,018,530,000
Average daily consumption (gallons), pump basis,	103,876,000
Gallons per day to each inhabitant, pump basis,	87.3

Distribution.

	Owned and operated by Metropolitan Water and Sewerage Board.	Total in District supplied by Metropolitan Water Works.
Kinds of pipe used,	-1	-1
Sizes,	76-4 inch.	76-4 inch.
Extensions, less length abandoned (miles),	0.03	27.74
Length in use (miles),	122.27	1,882.83
Stop-gates added,	5	-
Stop-gates now in use,	521	-
Service pipes added,	-	4,140
Service pipes now in use,	-	179,972
Meters added,	-	10,845
Meters now in use,	-	127,419
Fire hydrants added,	-	379
Fire hydrants now in use,	-	17,307

¹ Cast-iron, cement-lined wrought-iron, cement-lined steel and kalamine pipe.

APPENDIX NO. 4.

CONTRACTS MADE AND PENDING DURING

Contracts relating to the

1.	2.	3.	AMOUNT OF BID.		6.	
			4.	5.		
Number of Contract.	WORK.	Number of Bids.	Next to Lowest.	Lowest.	Contractor.	
1	127 ¹	425 tons of coal for Alewife Brook pumping station.	1	-	\$5.15 per ton. ²	Locke Coal Company, Malden.
2	128 ¹	1,200 tons of coal for Charlestown pumping station.	1	-	\$4.53 per ton. ²	Metropolitan Coal Company, Boston.
3	129 ¹	5,700 tons of coal: — 2,700 tons of coal for Deer Island pumping station. 3,000 tons of coal for East Boston pumping station.	2 3	\$4.58 per ton. \$4.47 per ton.	\$4.20 per ton. ² \$4.20 per ton. ²	New England Coal & Coke Company, Boston.
4	130 ¹	Cast-iron pipes and special castings for Section 1, Deer Island outfall extension, North Metropolitan System, Deer Island, Boston Harbor.	4	\$18,150 00	\$16,735 00 ²	United States Cast Iron Pipe and Foundry Co., Philadelphia, Penn.
5	131 ¹	Section 1A Deer Island outfall extension, temporary outfall sewer, North Metropolitan System, Deer Island, Boston Harbor.	5	44,358 75	43,370 00 ²	George M. Bryne, Boston.
6	132 ¹	Section 19, Reconstruction in new location of Malden River siphon, North Metropolitan System in Everett and Medford.	4	29,110 00	26,000 00 ²	George M. Bryne, Boston.
7	135	Section 1, Deer Island outfall extension, North Metropolitan System, Deer Island, Boston Harbor.	3	62,612 00	38,930 00 ²	Roy H. Beattie, Inc., Fall River.
8	137 ¹	Section 19, North Metropolitan System, removal of old Malden River siphon, in Everett and Medford.	4	8,000 00	6,758 00 ²	Boston Dredging Company, Boston.
9	140	6,900 tons of coal: — 2,700 tons for Deer Island pumping station. 3,000 tons for East Boston pumping station. 1,200 tons for Charlestown pumping station.	2 2 2	\$6.02 per ton. \$5.84 per ton. \$5.84 per ton.	\$5.90 per ton. ² \$5.65 per ton. ² \$5.75 per ton. ²	New England Coal and Coke Company, Boston.

¹ Contract completed.

APPENDIX NO. 4.

THE YEAR 1916 — SEWERAGE WORKS.

North Metropolitan System.

7.	8.	9.	10.	
Date of Contract.	Date of Completion of Work.	Prices of Principal Items of Contracts made in 1916.	Value of Work done Dec. 31, 1916.	
June 10, 1915	July 1, 1916	-	\$2,163 24	1
June 10, 1915	July 1, 1916	-	5,428 89	2
June 11, 1915	July 1, 1916	-	22,455 10	3
Aug. 27, 1915	June 30, 1916	-	17,245 98	4
Oct. 11, 1915	Nov. 6, 1916	-	44,367 25	5
Nov. 16, 1915	May 27, 1916	-	26,039 85	6
April 22, 1916	-	For earth excavation, laying and refilling in trench in the bed of the harbor for 84-inch to 48-inch cast-iron pipes, \$82 per lin. ft.; for furnishing and placing quarry-faced dimension granite at outlet, Station 2+58 to Station 3+22, \$8.40 per ton of 2,000 pounds; for furnishing and placing stone reinforcing and gravel or broken stone refilling under stone-work at outlets, Station 1+90 to Station 3+30, \$5.20 per ton of 2,000 pounds; for changes at existing outlet and connection to sewer, the lump sum of \$1,100.	24,165 20	7
June 30, 1916	Sept. 26, 1916	For removing old Malden River masonry siphon and head house (on Everett side), including all pilework foundation indicated on plans, and disposing of material, the lump sum of \$6,758.	6,950 00	8
June 14, 1916	-	\$5.90 per ton of 2,240 pounds delivered in bins at Deer Island pumping station. \$5.65 per ton of 2,240 pounds delivered in bins at East Boston pumping station. \$5.75 per ton of 2,240 pounds delivered in bins at Charlestown pumping station.	16,288 83	9

² Contract based upon this bid.

Contracts relating to the

1. Number of Contract.	2. WORK.	3. Num- ber of Bids.	AMOUNT OF BID.		6. Contractor.	
			4. Next to Lowest.	5. Lowest.		
1	123 ¹	Section 106, High-level sewer, Wellesley extension, South Metropolitan System in Needham and Wellesley.	7	\$37,651 00	\$27,912 50 ²	Hugh Nawn Contracting Company, Boston.
2	124 ¹	Section 105, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	7	37,272 50	29,655 00 ²	Hugh Nawn Contracting Company, Boston.
3	125 ¹	450 tons of coal for Quincy pumping station.	2	\$5.20 per ton.	\$4.99 per ton. ²	Frost Coal Company, Boston.
4	126 ¹	2,300 tons of coal for Ward Street pumping station.	2	\$5.05 per ton.	\$4.93 per ton. ²	Staples Coal Company, Boston.
5	127 ¹	550 tons of coal for Nut Island screen-house.	1	—	\$4.75 per ton. ²	Metropolitan Coal Company, Boston.
6	133	Section 104, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	8	\$64,272 50	\$59,055 00 ²	Bay State Dredging and Contracting Company, Boston.
7	134 ¹	Section 103, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	12	35,312 00	34,011 00 ²	Bruno and Petitti, Boston.
8	136	Two vertical fire tube boilers for Ward Street pumping station.	2	12,300 00	9,160 00 ²	D. M. Dillon Steam Boiler Works, Fitchburg.
9	138	Section 98, High-level sewer, Wellesley extension, South Metropolitan System in West Roxbury and Dedham.	3	79,040 00	54,630 00 ²	Thomas Russo & Co., Boston.
10	141	2,500 tons of coal for Ward Street pumping station.	1	—	\$5.63 per ton. ²	Staples Coal Company, Boston.
11	143	Section 102, High-level sewer, Wellesley extension, South Metropolitan System in Needham.	3	66,293 40	\$62,041 75 ²	Bruno & Petitti, Boston.

¹ Contract completed.

South Metropolitan System.

7.	8.	9.	10.	
Date of Contract.	Date of Completion of Work.	Prices of Principal Items of Contracts made in 1916.	Value of Work done Dec. 31, 1916.	
July 29, 1915	March 4, 1916	- -	\$35,482 26	1
July 29, 1915	Feb. 19, 1916	- -	36,955 84	2
June 9, 1915	July 1, 1916	- -	1,379 55	3
June 9, 1915	July 1, 1916	- -	10,537 11	4
June 10, 1915	July 1, 1916	- -	2,024 46	5
Dec. 22, 1915	-	- -	54,644 09	6
Dec. 22, 1915	Dec. 12, 1916	- -	36,674 97	7
May 20, 1916	-	Furnish and erect, ready for connection in the boiler room, on foundations furnished by the Board, two vertical fire tube boilers of 175 H.P. with working pressure of 150 lbs. per square inch.	-	8
July 13, 1916	-	Work abandoned by the Contractor before any portion was completed. Work provided for is now being completed in accordance with the specifications by Geo. M. Bryne.	1,094 75	9
June 14, 1916	-	\$5.63 per ton of 2,240 pounds delivered in bins at Ward Street pumping station.	3,416 89	10
Oct. 2, 1916	-	For earth excavation and refilling in trench and embankment for 27-in. by 30-in. concrete sewer, \$4.25 per lin. ft.; for Portland cement brick masonry in manholes and special structures, \$18 per cu. yd.; for Portland cement concrete masonry in trench and special structures, \$8.25 per cu. yd.; for spruce piles in trench in place, \$0.40 per lin. ft.; for rock excavation in trench, \$4 per cu. yd.	15,513 50	11

² Contract based upon this bid.

CONTRACTS MADE AND PENDING DURING THE YEAR 1916 — SEWERAGE WORKS
— *Concluded.*

Summary of Contracts.

	Value of Work done Dec. 31, 1916.
North Metropolitan System, 9 contracts,	\$165,104 34
South Metropolitan System, 11 contracts,	197,723 42
Total of 20 contracts made and pending during the year 1916,	\$362,827 76

APPENDIX No. 5.

FINANCIAL STATEMENT PRESENTED TO THE GENERAL COURT
ON JANUARY 16, 1917.

The Metropolitan Water and Sewerage Board respectfully presents the following abstract of the account of its receipts, expenditures, disbursements, assets and liabilities for the year ending November 30, 1916, together with recommendations for legislation which it deems desirable, in accordance with the provisions of chapter 235 of the Acts of the year 1906.

METROPOLITAN WATER WORKS.

Construction.

The loans authorized for expenditures under the Metropolitan Water acts, the receipts which are added to the loan fund, the expenditures for the construction and acquisition of works, and the balance available on December 1, 1916, have been as follows:—

Loans authorized under Metropolitan Water acts, . . .	\$42,798,000 00
Receipt from town of Swampscott for admission to Metropolitan Water District, paid into Loan Fund (St. 1909, c. 320), .	90,000 00
Receipts from the sales of property which are placed to the credit of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1916, .	\$5,894 43
For the period prior to December 1, 1915, .	244,703 38
	<hr/>
	250,597 81
	<hr/>
	\$43,138,597 81
Amount approved for payment by the Board out of the Metropolitan Water Loan Fund:—	
For the year ending November 30, 1916, .	\$115,913 25
For the period prior to December 1, 1915, .	42,795,989 89
	<hr/>
	42,911,903 14
	<hr/>
Balance December 1, 1916,	\$226,694 67

The amount of the Metropolitan Water Loan bonds issued at the end of the fiscal year was \$42,602,000, bonds to the amount of \$66,000 having been issued during the year. Of the total amount issued, \$41,398,000 were sinking fund bonds, and the remainder, amounting to \$1,204,000, were issued as serial bonds.

At the end of the year the amount of the outstanding bonds was \$42,530,000, as bonds issued on the serial payment plan to the amount of \$72,000 had been paid. During the fiscal year \$30,000 in serial bonds has been paid.

The Metropolitan Water Loan Sinking Fund amounted on December 1, 1916, to \$13,268,199.36, an increase during the year of \$776,954.11.

The net debt on December 1, 1916, was \$29,261,800.64, a decrease during the fiscal year of \$740,954.11.

Maintenance.

Amount appropriated for the maintenance and operation of works, for the year ending November 30, 1916,	\$480,850 00	
Special appropriation for protection of water supply in aqueducts (1911) remaining,	9,930 60	
Special appropriations for protection and improvement of the water supply (1912 and 1913) remaining,	4,588 31	
Receipts credited to this fund for the year ending November 30, 1916,	46,011 06	
	<hr/>	\$541,379 97
Amount approved by Board for maintenance and operation of works during the year ending November 30, 1916,	457,278 88	
	<hr/>	\$84,101 09
Balance December 1, 1916,		

This balance includes the sum of \$9,930.60, the amount remaining unexpended of the special appropriation for the protection of the water supply in aqueducts, and the sums of \$2,713.93, the amount remaining unexpended of the special appropriation in 1912, and \$66.20 of the special appropriation in 1913 and \$18,675 of the appropriation in 1916 for the protection and improvement of the water supply.

The Board has also received during the year ending November 30, 1916, \$46,011.06 from rentals, the sale of land, land products and power and from other proceeds from the operations of the Board, which, according to section 18 of the Metropolitan Water Act, are applied by the Treasurer of the Commonwealth to the payment of interest on the Metropolitan Water Loan, to sinking fund requirements, and expenses of maintenance and operation of works, in reduction of the amount to be assessed upon the Metropolitan Water District for the year.

Sums received from sales of water to municipalities not belonging to the District and to water companies, and from municipalities for admission to the District, have been applied as follows:—

For the period prior to December 1, 1906, distributed to the cities and towns of the District, as provided by section 3 of the Metropolitan Water Act,	\$219,865 65
For the period beginning December 1, 1906, and prior to December 1, 1915, applied to the Metropolitan Water Loan Sinking Fund, as provided by chapter 238 of the Acts of 1907,	65,644 88
For the year beginning December 1, 1915, and ending November 30, 1916, applied to the Metropolitan Water Loan Sinking Fund, as provided by said last-named act,	7,021 19
	<u>\$292,531 72</u>

METROPOLITAN SEWERAGE WORKS.

Construction.

The loans authorized under the various acts of the Legislature for the construction of the Metropolitan Sewerage Works, the receipts which are added to the proceeds of the loans, and the expenditures for construction, are given below, as follows:—

North Metropolitan System

Loans authorized for expenditures for construction under the various acts, including those for the Revere, Belmont and Malden extensions, North System enlargements and extensions, New Mystic sewer, Deer Island outfall extension, lowering sewer siphon under Malden River, balance of appropriation under chapter 76, Resolves of 1915, and for the Reading extension,	\$7,512,365 73
Receipts from sales of real estate and from miscellaneous sources, which are placed to the credit of the North Metropolitan System:—	
For the year ending November 30, 1916,	132 10
For the period prior to December 1, 1915,	\$5,516 79
Amount approved for payment by the Board ¹ out of the Metropolitan Sewerage Loan Fund, North System:—	
For the year ending November 30, 1916,	\$124,901 38
For the period prior to December 1, 1915,	7,121,633 11
	<u>\$7,598,014 62</u>
	\$7,246,534 49
Balance December 1, 1916,	\$351,480 13

¹ The word "Board" refers to the Metropolitan Sewerage Commission and its successor, the Metropolitan Water and Sewerage Board.

South Metropolitan System.

Loans authorized for expenditures for construction under the various acts, applied to the construction of the Charles River valley sewer, Neponset valley sewer, High-level sewer and extensions (including Wellesley branch), an additional appropriation authorized by chapter 210, General Acts of 1915, and for additional Ward Street station pumping plant, . . .			\$9,262,046	27
Receipts for pumping, sales of real estate and from miscellaneous sources, which are placed to the credit of the South Metropolitan System: —				
For the year ending November 30, 1916, .			37	16
For the period prior to December 1, 1915, .			19,064	25
Amount approved by Board for payment as follows: —				
On account of the Charles River valley sewer,			\$800,046	27
On account of the Neponset valley sewer, .			911,531	46
On account of the High-level sewer and extensions: —				
For the year ending November 30, 1916,			172,806	30
For the period prior to December 1, 1915,			7,211,599	37
			<hr/>	
			\$9,281,147	68
			\$9,095,983	40
Balance December 1, 1916,			\$185,164	28

The amount of the Metropolitan Sewerage Loan bonds issued at the end of the fiscal year was \$16,436,412, bonds to the amount of \$425,000 having been issued during the year. Of the total amount issued, \$15,440,912 were sinking fund bonds, and the remainder, amounting to \$995,500, were serial bonds.

At the end of the year the amount of the outstanding bonds was \$16,377,912, as bonds issued on the serial payment plan to the amount of \$29,500 had been paid during the year, \$58,500 having been paid to December 1, 1916.

Of the total amount outstanding at the end of the year, \$7,155,000 was issued for the North Metropolitan System and \$9,222,912 for the South Metropolitan System. The Metropolitan Sewerage Loan Sinking Fund amounted on December 1, 1916, to \$3,604,657.27, of which \$2,284,055.75 was on account of the North Metropolitan System and \$1,320,601.52 was on account of the South Metropolitan System, an increase during the year of \$313,677.81.

The net debt on December 1, 1916, was \$12,773,254.73, an increase of \$81,822.19.

Included in the above figures for the North Metropolitan System is \$640,500 in serial bonds, of which \$48,500 has been paid, and \$355,000 for the South Metropolitan System, of which \$10,000 has been paid.

Maintenance.

North Metropolitan System.

Appropriated for the year ending November 30, 1916,	\$180,000 00
---	--------------

Receipts from pumping and from other sources, which are returned to the appropriation: —	
--	--

For the year ending November 30, 1916,	1,947 73
--	----------

	\$181,947 73
--	--------------

Amount approved for payment by the Board: —

For the year ending November 30, 1916,	178,310 72
--	------------

Balance December 1, 1916,	\$3,637 01
-------------------------------------	------------

South Metropolitan System.

Appropriated for the year ending November 30, 1916,	\$115,000 00
---	--------------

Receipts from sales of property and for pumping, which are returned to the appropriation: —	
---	--

For the year ending November 30, 1916,	525 57
--	--------

	\$115,525 57
--	--------------

Amount approved for payment by the Board: —

For the year ending November 30, 1916,	115,320 12
--	------------

Balance December 1, 1916,	\$205 45
-------------------------------------	----------

APPENDIX No. 6.

LEGISLATION OF THE YEAR 1916 AFFECTING THE
METROPOLITAN WATER AND SEWERAGE BOARD.

General Acts, 1916.

CHAPTER 2.

AN ACT RESTRICTING INCREASES IN SALARY OF CERTAIN
STATE EMPLOYEES.*Be it enacted, etc., as follows:*

Increases in
salary of
certain State
employees
restricted.

SECTION 1. Without the consent and approval of the governor and council it shall be unlawful for any head of a department or other officer of the commonwealth to increase the salary of any employee under his direction who is receiving an annual salary of one thousand dollars or more, notwithstanding any act heretofore passed authorizing such an increase.

SECTION 2. This act shall take effect upon its passage.
[Approved February 7, 1916.]

CHAPTER 14.

AN ACT RELATIVE TO PROSECUTIONS UNDER THE LAW
PROVIDING FOR WEEKLY PAYMENT OF WAGES.*Be it enacted, etc., as follows:*

1909, 514, § 113,
amended.

Section one hundred and thirteen of chapter five hundred and fourteen of the acts of the year nineteen hundred and nine is hereby amended by striking out the words "The chief of the district police or an inspector of factories and public buildings", in the first and second lines, and inserting in place thereof the words: — The state board of labor and industries, — and by striking out the words "thirty days", in the fifth line, and inserting in place thereof the words: — three months, — so as to read as follows: — *Section 113.* The state board of labor and industries may make a complaint against any person for a violation of the provisions of the preceding section. Complaints for such violation shall

State board of
labor and indus-
tries to prosecute
violations of
law providing
for weekly pay-
ment of wages.

be made within three months after the date thereof, and, on the trial, no defence for failure to pay as required, other than the attachment of such wages by the trustee process or a valid assignment thereof or a valid set-off against the same, or the absence of the employee from his regular place of labor at the time of payment, or an actual tender to such employee at the time of payment of the wages so earned by him, shall be valid. The defendant shall not set up as a defence a payment of wages after the bringing of the complaint. An assignment of future wages which are payable weekly under the provisions of this act shall not be valid if made to the person from whom such wages are to become due or to any person on his behalf or if made or procured to be made to another person for the purpose of relieving the employer from the obligation to pay weekly. The word "person" in this section shall include the corporations, contractors, persons and partnerships described in the preceding section. [Approved February 25, 1916.]

CHAPTER 90.

AN ACT TO PROVIDE FOR COMPENSATING INJURED EMPLOYEES WHO ARE INCAPACITATED FOR MORE THAN TEN DAYS.

Be it enacted, etc., as follows:

SECTION 1. Part II of chapter seven hundred and fifty-one of the acts of the year nineteen hundred and eleven, and acts in amendment thereof, is hereby amended by striking out section four and inserting in place thereof the following: — *Section 4.* No compensation shall be paid under this act for any injury which does not incapacitate the employee for a period of at least ten days from earning full wages, but if incapacity extends beyond the period of ten days, compensation shall begin on the eleventh day after the injury. When compensation shall have begun, it shall not be discontinued except with the written assent of the employee or the approval of the board, or a member thereof: *provided, however,* that such compensation shall be paid in accordance with section ten of Part II of said chapter seven hundred and fifty-one, as amended by section five of chapter seven hundred and eight of the acts of the year nineteen hundred and fourteen, if the employee in fact

1911, 751, Part II, § 4, etc., amended.

Compensation for injured employees incapacitated for more than ten days.

Proviso.

earns wages at any time after the original agreement is filed.

Time of taking effect.

SECTION 2. This act shall take effect on the first day of January in the year nineteen hundred and seventeen. [Approved March 31, 1916.]

CHAPTER 93.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE IMPROVEMENTS AT THE WARD STREET PUMPING STATION IN THE CITY OF BOSTON.

Be it enacted, etc., as follows:

Metropolitan water and sewerage board may install pumping engine, etc., at Ward Street pumping station.

Metropolitan Sewerage Loan.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to install a pumping engine and two boilers and the necessary connections at the Ward street pumping station in the city of Boston.

SECTION 2. To meet the expenses incurred under the provisions of this act the treasurer and receiver general shall issue from time to time, in the name and behalf of the commonwealth and under its seal, and in addition to the amount of such bonds heretofore authorized for the construction of the south metropolitan sewerage works, bonds designated on the face thereof, Metropolitan Sewerage Loan, to an amount not exceeding forty thousand dollars.

Certain provisions of law to apply.

SECTION 3. The provisions of chapter four hundred and twenty-four of the acts of the year eighteen hundred and ninety-nine, and of all acts in amendment thereof and in addition thereto, shall apply, so far as applicable, to the indebtedness authorized by this act and to all proceedings hereunder.

SECTION 4. This act shall take effect upon its passage. [Approved April 3, 1916.]

CHAPTER 94.

AN ACT TO EXCLUDE DUDLEY POND IN THE TOWN OF WAYLAND FROM THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Dudley pond in Wayland excluded from metropolitan water system.

SECTION 1. The metropolitan water and sewerage board may close and terminate the existing connection between Lake Cochituate and Dudley pond in the town of Wayland,

and may transfer and release to said town all interest in and control over the waters of said pond. Thereafter Dudley pond shall not be used as a source of water supply by the metropolitan water district or by any city or town, nor shall it be allowed to overflow into Lake Cochituate or be connected with the water supply of said district or of any city or town, and the pond shall be subject to the control and regulation of the town of Wayland which is hereby authorized to impose penalties for the violation of any regulations made by said town in respect to the said pond.

SECTION 2. This act shall take effect upon its passage.
[Approved April 3, 1916.]

CHAPTER 96.

AN ACT TO AUTHORIZE THE METROPOLITAN PARK COMMISSION TO PROVIDE FOR THE DISPOSAL OF SEWAGE FROM THE RIVERSIDE RECREATION GROUNDS.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan park commission is authorized to connect the sewerage system of the Riverside recreation grounds, so-called, situated on the westerly side of Charles river in the town of Weston, with the sewerage system of the city of Newton, at such point and upon such terms as may be agreed upon by said commission and city. All sewage so received may be discharged into the south metropolitan sewerage system, provided that the terms aforesaid are approved by the metropolitan water and sewerage board, and that such further provisions as the said board may deem necessary or proper are complied with.

Disposal of sewage from the Riverside recreation grounds.

SECTION 2. This act shall take effect upon its passage.
[Approved April 3, 1916.]

CHAPTER 100.

AN ACT TO PERMIT OWNERS OF CERTAIN LAND IN NEEDHAM TO CONNECT THE SAME WITH THE MAIN TRUNK SEWER OF THE SOUTH METROPOLITAN SEWERAGE SYSTEM.

Be it enacted, etc., as follows:

SECTION 1. The metropolitan water and sewerage board may, upon such terms and conditions as said board may determine, permit the owners of land in the town of Needham, through which passes the main trunk sewer provided

Owners of certain land in Needham may connect with south metropolitan sewerage system.

for by chapter three hundred and forty-three of the acts of the year nineteen hundred and fourteen, to connect by private drains with said sewer, and thereby to discharge their sewage into the south metropolitan sewerage system. The said board may also determine whether said owners shall pay for said privilege and, if so, the amount and time of payment. If payment is required it shall be made to said board and applied to the maintenance and operation of the south metropolitan sewerage system. Such payment shall cease upon the admission of the town of Needham into the south metropolitan sewerage district.

SECTION 2. This act shall take effect upon its passage.
[Approved April 4, 1916.]

CHAPTER 159.

AN ACT TO PROVIDE FOR THE ADDITION OF THE TOWN OF
READING TO THE NORTH METROPOLITAN SEWERAGE
DISTRICT.

Be it enacted, etc., as follows:

Town of Reading added to north metropolitan sewerage district.

SECTION 1. The territory comprising the town of Reading is hereby added to the north metropolitan sewerage district created by chapter four hundred and thirty-nine of the acts of the year eighteen hundred and eighty-nine and acts in amendment thereof and in addition thereto. In becoming a part of said district, said addition shall be subject to the provisions and shall conform to the requirements of the said acts, except as is otherwise provided herein. Any authority granted to other municipalities by said acts is hereby also vested in the town of Reading in common with such other municipalities.

Outlet to be provided at Reading town line.

SECTION 2. The metropolitan water and sewerage board shall provide an outlet at the Reading town line in or near Brook street for the sewage of said town, and, acting on behalf of the commonwealth shall construct a main trunk sewer or sewers through such parts of the towns of Wakefield and Stoneham and the city of Woburn from the Reading town line to such point in the north metropolitan system as said board may determine to be necessary in order to connect with a main trunk sewer in the Mystic valley.

The metropolitan water and sewerage board to exercise

SECTION 3. In providing said outlet and in receiving sewage from said town, and in any action in relation thereto,

and for the purpose of taking, constructing and maintain-
 ing such additional main lines of sewers, the metropolitan
 water and sewerage board, acting on behalf of the
 commonwealth, shall have and exercise all the authority
 conferred upon it by said chapter four hundred and thirty-
 nine, and by chapter one hundred and sixty-eight of the
 acts of the year nineteen hundred and one and by acts in
 amendment thereof and in addition thereto; and all the
 provisions of said acts are made applicable to the additional
 construction, maintenance and operation hereby authorized
 except as is otherwise provided herein.

certain au-
 thority, etc.

SECTION 4. To meet the expenses incurred under the
 provisions of this act, the treasurer of the commonwealth
 shall from time to time issue in the name and behalf of the
 commonwealth and under its seal, bonds, designated on the
 face thereof, Metropolitan Sewerage Loan, for a term not
 exceeding forty years, to an amount not exceeding two hun-
 dred and eighty-five thousand dollars in addition to the
 amount of such bonds heretofore authorized for the con-
 struction of the north metropolitan sewerage works. The
 provisions of chapter four hundred and thirty-nine of the
 acts of the year eighteen hundred and eighty-nine and chap-
 ter four hundred and twenty-four of the acts of the year
 eighteen hundred and ninety-eight, and all acts in amend-
 ment thereof and in addition thereto shall, so far as they
 are applicable, apply to the indebtedness authorized by this
 act.

Metropolitan
 Sewerage Loan.

Certain
 provisions of
 law to apply.

SECTION 5. The interest and sinking fund requirements
 on account of the moneys expended in constructing that
 part of the sewerage system provided for in this act, and
 the cost of the maintenance and operation thereof, shall be
 deemed to be, and shall be paid as, a part of the interest,
 sinking fund requirements and costs specified in said chap-
 ter four hundred and thirty-nine of the acts of the year
 eighteen hundred and eighty-nine and acts in amendment
 thereof and in addition thereto, and shall be apportioned,
 assessed and collected in the manner provided by that chap-
 ter and acts in amendment thereof and in addition thereto
 except as is otherwise provided herein. The town of
 Reading shall, in addition to the yearly payment of the
 assessment above provided for, pay into the treasury of
 the commonwealth for the sinking fund of the north metro-
 politan sewerage district the sum of thirty-five thousand

Interest, etc.,
 how appor-
 tioned, etc.

Share of in-
 terest and
 sinking fund
 requirements
 to be paid by
 Reading.

dollars, as follows: — one fifth of the said amount shall be added to the yearly sum payable by said town on account of its share of the interest and sinking fund requirements of the district for the succeeding five years. No assessment on account of maintenance requirements of the north metropolitan sewerage district shall be made upon said town until the calendar year in which its sewers shall be connected with the north metropolitan system as herein provided.

When
assessments
commence.

Time of taking
effect.

SECTION 6. This act shall take full effect when accepted by vote of a majority of the legal voters of the town of Reading present and voting thereon at a meeting called for the purpose. [*Approved April 26, 1916.*]

CHAPTER 172.

AN ACT TO AUTHORIZE THE METROPOLITAN WATER AND SEWERAGE BOARD TO MAKE CERTAIN IMPROVEMENTS IN THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

Metropolitan
water and
sewerage board
may make
certain im-
provements in
metropolitan
water system.

SECTION 1. The metropolitan water and sewerage board is hereby authorized to construct a line for the transmission of electricity between the power station at the Wachusett Dam in Clinton and the power station at the Sudbury Dam in Southborough; to relocate and connect meters for the measuring of water supplied through the low service to the metropolitan water district; to construct a 12-inch pipe line in Poplar street, West Roxbury, and under the Neponset river; and to install a new pumping engine at the Arlington pumping station.

Metropolitan
Water Loan.

SECTION 2. To meet the expenses incurred under the provisions of this act, the treasurer and receiver general shall issue from time to time upon the request of said board, bonds in the name and behalf of the commonwealth designated on the face thereof, Metropolitan Water Loan, Act of 1916, to an amount not exceeding one hundred and fifty thousand dollars, to be taken from the unexpended balance of one hundred and ninety-six thousand dollars appropriated by chapter six hundred and ninety-four of the acts of the year nineteen hundred and twelve; and the provisions of chapter four hundred and eighty-eight of the acts of the year eighteen hundred and ninety-five and acts in amendment thereof and in addition thereto, shall, so far as appli-

cable, apply to the indebtedness and proceedings authorized by this act.

SECTION 3. This act shall take effect upon its passage.
[Approved May 3, 1916. .

CHAPTER 240.

AN ACT RELATIVE TO THE HOURS OF LABOR OF PUBLIC EMPLOYEES AND PERSONS EMPLOYED ON PUBLIC WORKS.

Be it enacted, etc., as follows:

SECTION 1. Section one of chapter four hundred and ninety-four of the acts of the year nineteen hundred and eleven is hereby amended by inserting after the word "day", in the tenth line, the words: — and to forty-eight hours in any one week, — and by inserting after the word "day", in the seventeenth line, the words: — or more than forty-eight hours in any one week, — so as to read as follows: — *Section 1.* The service of all laborers, workmen and mechanics, now or hereafter employed by the commonwealth or by any county therein or by any city or town which has accepted the provisions of section twenty of chapter one hundred and six of the Revised Laws, or of section forty-two of chapter five hundred and fourteen of the acts of the year nineteen hundred and nine, or by any contractor or sub-contractor for or upon any public works of the commonwealth or of any county therein or of any such city or town, is hereby restricted to eight hours in any one calendar day, and to forty-eight hours in any one week, and it shall be unlawful for any officer of the commonwealth or of any county therein, or of any such city or town, or for any such contractor or sub-contractor or other person whose duty it shall be to employ, direct or control the service of such laborers, workmen or mechanics to require or permit any such laborer, workman or mechanic to work more than eight hours in any one calendar day, or more than forty-eight hours in any one week, except in cases of extraordinary emergency. Danger to property, life, public safety or public health only shall be considered cases of extraordinary emergency within the meaning of this section. In cases where a Saturday half holiday is given the hours of labor upon the other working days of the week may be increased sufficiently to make a total of forty-eight hours for the

1911, 494, § 1,
amended.

Hours of labor
of public
employees and
persons em-
ployed on
public works
fixed.

"Extraordinary
emergency"
term defined.

week's work. Threat of loss of employment or to obstruct or prevent the obtaining of employment or to refrain from employing in the future, shall each be considered to be "requiring" within the meaning of this section. Engineers shall be regarded as mechanics within the meaning of this act.

1911, 494, § 4,
amended.

SECTION 2. Section four of chapter four hundred and ninety-four of the acts of the year nineteen hundred and eleven is hereby amended by adding at the end thereof the following: — nor to persons employed by the trustees of the Massachusetts nautical school, on boats maintained by the district police for the enforcement of certain laws in the waters of the commonwealth, or in connection with the care and maintenance of state armories, — so as to read as follows: — *Section 4.* This act shall not apply to the preparation, printing, shipment and delivery of ballots to be used at a caucus, primary, state, city or town election, nor during the sessions of the general court to persons employed in legislative printing or binding; nor shall it apply at any time to persons employed in any state, county or municipal institution, on a farm, or in the care of the grounds, in the stable, in the domestic or kitchen and dining room service or in store rooms or offices, nor to persons employed by the trustees of the Massachusetts nautical school, on boats maintained by the district police for the enforcement of certain laws in the waters of the commonwealth, or in connection with the care and maintenance of state armories.

Not to apply
in certain cases.

Time of taking
effect.
Proviso.

SECTION 3. This act shall take effect on the first day of July, nineteen hundred and sixteen: *provided, however,* that the provisions of section one shall not take effect in any city until accepted by vote of the city council, approved by the mayor, or by vote of the commission in any city under a commission form of government, nor in any town until accepted by the voters thereof at an annual meeting or at a special meeting called for the purpose. [*Approved May 20, 1916.*]

CHAPTER 251.

AN ACT RELATIVE TO THE DISCHARGE AND SUBSTITUTION OF BONDS GIVEN TO THE COMMONWEALTH.

Be it enacted, etc., as follows:

Discharge and
substitution of
bonds given to
the common-
wealth.

SECTION 1. Bonds or other security given to the commonwealth to secure the performance of contracts for the construction or repair of public buildings or other public

works, or given in accordance with section seventy-seven of chapter six of the Revised Laws, may be discharged or released by the governor, with the advice and consent of the council, upon such terms as may be deemed expedient, after the expiration of sixty-five days from the time of the completion of the work contracted to be done: *provided*, Proviso. that no claim filed under the provisions of section seventy-seven of chapter six of the Revised Laws is pending; and new bonds or other security in substitution therefor may be taken by the governor, with like advice and consent.

SECTION 2. This act shall take effect upon its passage.
[Approved May 24, 1916.]

CHAPTER 258.

AN ACT RELATIVE TO A HALF HOLIDAY FOR LABORERS AND MECHANICS OF THE METROPOLITAN WATER AND SEWERAGE BOARD AND THE METROPOLITAN PARK COMMISSION.

Be it enacted, etc., as follows:

Section one of chapter five hundred and twenty-eight of the acts of the year nineteen hundred and twelve, as amended by chapter four hundred and fifty-five of the acts of the year nineteen hundred and fourteen, is hereby further amended by striking out the word "permanent", in the first and thirteenth lines, respectively; and also by striking out the words "during the months of April, May, June, July, August and September", in the seventh and eighth lines, so as to read as follows:—*Section 1.* Laborers and mechanics in the service of the metropolitan water and sewerage board or the metropolitan park commission, except those employed in the pumping stations of the metropolitan water and sewerage board and at the bath houses under the control of the metropolitan park commission, shall be given a half holiday each week without loss of pay, and, if practicable, the half holiday shall be on Saturday. If, however, the public service so requires, the metropolitan park commission and the metropolitan water and sewerage board may at any time during the year give to the laborers and mechanics in their service, in lieu of the said half holidays, days off duty without loss of pay equivalent in time to the half holidays which would otherwise be given under this act. [Approved May 24, 1916.]

1912, 528, § 1,
etc., amended.

Half holidays
for laborers,
etc., of met-
ropolitan water
and sewerage
board and
metropolitan
park com-
mission.

Special Acts, 1916.

CHAPTER 167.

AN ACT MAKING AN APPROPRIATION FOR THE MAINTENANCE
AND OPERATION OF THE NORTH METROPOLITAN SEWER-
AGE SYSTEM.

Be it enacted, etc., as follows:

North metro-
politan sew-
erage system,
maintenance.

SECTION 1. A sum not exceeding one hundred and eighty thousand dollars is hereby appropriated, to be paid out of the North Metropolitan Sewerage System Maintenance Fund, for the maintenance and operation of a system of sewage disposal for the cities included in what is known as the north metropolitan sewerage system, during the fiscal year ending on the thirtieth day of November, nineteen hundred and sixteen.

SECTION 2. This act shall take effect upon its passage.
[Approved March 8, 1916.]

CHAPTER 168.

AN ACT MAKING AN APPROPRIATION FOR THE MAINTENANCE
AND OPERATION OF THE SOUTH METROPOLITAN SEWER-
AGE SYSTEM.

Be it enacted, etc., as follows:

South metro-
politan sew-
erage system,
maintenance.

SECTION 1. A sum not exceeding one hundred and fifteen thousand dollars is hereby appropriated, to be paid out of the South Metropolitan Sewerage System Maintenance Fund, for the cost of maintenance and operation of the south metropolitan sewerage system, comprising a part of Boston, the cities of Newton and Waltham and the towns of Brookline, Watertown, Dedham and Milton, during the fiscal year ending on the thirtieth day of November, nineteen hundred and sixteen.

SECTION 2. This act shall take effect upon its passage.
[Approved March 8, 1916.]

CHAPTER 198.

AN ACT MAKING AN APPROPRIATION FOR THE MAINTENANCE
AND OPERATION OF THE METROPOLITAN WATER SYSTEM.

Be it enacted, etc., as follows:

SECTION 1. A sum not exceeding four hundred eighty thousand eight hundred and fifty dollars is hereby appropriated, to be paid out of the Metropolitan Water Maintenance Fund, for the maintenance and operation of the metropolitan water system for the cities and towns in what is known as the metropolitan water district, during the fiscal year ending on the thirtieth day of November, nineteen hundred and sixteen: *provided*, that of the said sum twenty thousand dollars shall be reserved for the protection and improvement of water supplies by the purchase of land or otherwise.

Metropolitan
water system,
maintenance.

Proviso.

SECTION 2. This act shall take effect upon its passage.
[Approved March 21, 1916.]

INDEX TO LEGISLATION OF THE YEAR 1916 AFFECTING THE METROPOLITAN WATER AND SEWERAGE BOARD.

A.

APPROPRIATIONS.

	Chap.	Sect.
for admission of Reading to North Metropolitan Sewerage District,	G. 159	4
for certain improvements in Metropolitan Water System, . . .	G. 172	2
for improvements at Ward Street pumping station, . . .	G. 93	2
for maintenance of Metropolitan Water System, . . .	S. 198	1
for maintenance of North Metropolitan Sewerage System, . . .	S. 167	1
for maintenance of South Metropolitan Sewerage System, . . .	S. 168	1

B.

BONDS.

relative to discharge and substitution of, given to Commonwealth,	G. 251	1
---	--------	---

D.

DUDLEY POND.

to be excluded from Metropolitan Water System,	G. 94	1
--	-------	---

E.

EMPLOYEES, STATE.

relative to half holiday for certain,	G. 258	-
relative to hours of labor for certain,	G. 240	1, 2
restricting increases in salary of certain,	G. 2	1

M.

METROPOLITAN WATER AND SEWERAGE BOARD.

to install additions to pumping plant at Ward Street station, . . .	G. 93	1
to make certain improvements in Metropolitan Water System, . . .	G. 172	1

METROPOLITAN WATER SYSTEM.

appropriation for maintenance of,	S. 198	1
---	--------	---

N.

NEEDHAM.

owners of certain land in, to connect with South Metropolitan Sewerage System,	G. 100	1
--	--------	---

NORTH METROPOLITAN SEWERAGE SYSTEM.

addition of Reading to,	G. 159	1
appropriation for maintenance of,	S. 167	1

R.**READING.**

	Chap.	Sect.
addition of town of, to North Metropolitan Sewerage District,	G. 159	1

RIVERSIDE RECREATION GROUNDS.

relative to disposal of sewage from,	G. 96	1
--------------------------------------	-------	---

S.**SOUTH METROPOLITAN SEWERAGE SYSTEM.**

appropriation for maintenance of,	S. 168	1
-----------------------------------	--------	---

W.**WAGES.**

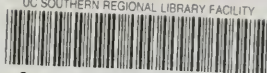
weekly payment of, to public employees, prosecutions under law,	G. 14	-
---	-------	---

WORKMEN'S COMPENSATION ACT.

compensation of injured employees incapacitated more than ten		
days,	G. 90	1

UNIVERSITY of CALIFORNIA
AT
LOS ANGELES
LIBRARY

UC SOUTHERN REGIONAL LIBRARY FACILITY



A 000 391 964 4

